

THE

B.H.P. REVIEW

JUBILEE NUMBER



AUSTRALIA
JUNE
1935

FIFTY YEARS OF INDUSTRY AND ENTERPRISE

1885
TO
1935

THE BROKEN HILL PROPRIETARY COMPANY LIMITED—AUSTRALIA



NEWCASTLE, New South Wales	Steelworks, Collieries,
IRON KNOB, South Australia	Allied and Subsidiary Industries
WHYALLA, South Australia	Iron Ore Mines
DEVONPORT (Melrose), Tasmania	Port for Iron Knob
KALGOORLIE, Western Australia	Limestone Quarries
BROKEN HILL, New South Wales	Gold Mines
MELBOURNE, Victoria	Silver Lead Mine
SYDNEY, New South Wales	Head Office
ADELAIDE, South Australia	Branch Office
PERTH, Western Australia	Branch Office

And at LONDON, England



FOREWORD

A MILESTONE that registers fifty years in the life of a many-phased enterprise prompts retrospect and depiction. In this Jubilee Number of "The B.H.P. Review" an endeavour has been made to portray the origins and to survey the successive stages of mining and industrial activities that have contributed in no small degree to the industrial expansion of the Commonwealth.

Scientific development of mining has at all times been a primary objective of The Broken Hill Proprietary Company Ltd., and its appreciation of the basic importance of national self-containment in iron and steel is even keener.

Apart from the transcendent obligations of defence, adequate steel is indispensable to industrial capacity, a vital basis of the measureless expansion of which the Commonwealth is capable. The value of steel for all purposes of peace or war is heightened in proportion to Australia's distance from her partners in the Imperial Commonwealth.

Adventure and courage illumine the record, and Australians of to-day are reminded of the immense debt owed to the far-sighted men who pioneered the steel industry, and to the conspicuous technical and administrative ability dedicated to the achievements here set forth.

Although the life of the Company now extends over half a century, only twenty years have elapsed since the great Newcastle works were opened at a critical stage of Australia's fortunes. Within that short period has been developed one of the most comprehensive plants in the British Commonwealth. The magnitude of equipment, range of operations and record of production vindicate the spirit that launched the enterprise.

The publication is offered in the hope that it may interest the layman as well as the technician in Australia and abroad.

No effort has been spared to ensure accuracy. The aim has been to present, not only the record of the past, but also a faithful picture of contemporary equipment and activities that engage a host of skilled and efficient Australian workers.

Allied industries are also described, as in each case The B.H.P. controls, has a substantial shareholding in them, or supplies their raw material.

The history of the smelters at Port Pirie is given in view of the Company's earlier interest in these works, now owned by The Broken Hill Associated Smelters Pty. Ltd.

Ernest J. Hewitt

Managing Director.



THE BROKEN HILL PROPRIETARY COMPANY LTD. IRON & STEEL WORKS
NEWCASTLE, NEW SOUTH WALES.



THE BROKEN HILL

ROMANCE AND HARDSHIP OF THE EARLY DAYS



OUTLOOK FROM BARRIER RANGES, ABOUT 1845.

HOW the fabulous silver-lead deposits of Broken Hill were disturbed from their age-long quietude forms one of the most picturesque if fevered episodes in Australian history. How the far-famed Hill was made to yield its abundant treasure and thus gave its name to great mining and industrial "enterprises of pith and moment" in the national fortunes, supplies an equally-absorbing sequel, a yet uncompleted third act of the moving drama.

The great English navigator, Capt. Matthew Flinders, R.N., and the English explorer whom Australians have most cause to honour, Capt. Charles Sturt, were the first white men to visit and record the coast and ranges upon which The Broken Hill Proprietary Co. Ltd. has made history. On the tragic expedition of 1844-5, which searched for a legendary inland sea, Sturt stood on the "broken hill" itself. Neither, however, conjectured that the sun-scorched country, so arid to English eyes, would, or could, bear significantly on the destinies of a new nation.

STURT ON THE HILL

In October, 1844, Sturt and party were camped on what is now known as Stephen's Creek. Sturt, with John Poole, his second in command, rode out from the camp, climbing to the top of a grim, broken-backed ridge, 150 feet above the plain. From there Sturt hoped to look out on the "great inland sea" which Poole believed he had seen from the Barrier ranges. Looking from that "broken hill," Sturt recognised that Poole had looked upon a mirage.

The disappointed explorer carried from the hill specimens of ore which he handed to the Government of South Australia. Officialdom lost them. The secret of the hill was to remain hidden for another 40 years. Throughout the gold rushes of the "roaring fifties" the barrier ranges remained unheeded. But in the Eighteen-sixties, miners, disappointed of success on existing gold-fields, commenced search further afield. From stockmen and teamsters they learned of the existence of white quartz in the Barrier ranges, which meant gold. A small army invaded the drought-stricken area. Unhappily, drought proved fatal to many and profitless to all. The few who reached the Barrier were seeking gold and despised the silver show. They hastened away from the sun-scorched, waterless and sterile range.



THE MOUNT GIPPS STATION

With the passing of the years there came a great change. The squatters had taken possession of the saltbush, and one big area, known as Mount Gipps station owned by McCulloch, Sellars & Co., of Melbourne, had its headquarters on Mount Gipps Creek, a tributary of Stephen's Creek. The



GEORGE McCULLOCH.

syndicate was headed by Sir James McCulloch, then Premier of Victoria, the station property, a sheep proposition, being managed by his nephew, George McCulloch. The district was arid, forbidding, and but sparsely populated. A few grog-shanties stood by water-courses or soakages which at irregular intervals marked the stock routes from Queensland to Adelaide. These formed the centres from which, through the Eighteen-seventies, the silver-lead ores of the Barrier were exploited. Slowly the wealth of the field as a silver producer won recognition, and in the early eighties fortune hunters, promoters, prospectors, and miners concentrated on the Barrier. Over a silver-field of 36 square miles, many mines, such as the Day Dream and Pioneer, famous in their day, were developed. The town of Silverton grew to a population of 3,000 souls, and the field became famous as the Silver Barrier.

THE BOUNDARY RIDER

Not far away stood a grim, hog-backed hill, whose outline earned it the descriptive title of the "broken hill." This black, burnished landmark, denuded of almost all vegetation except mulga scrub, was reserving its smiles and its fortune for those who would be courageous enough to exploit it.

In September, 1883, the first of the little band whose members were to woo and win the hill's favour appeared. Charles Rasp, a young boundary rider of Mount Gipps station, who prospected in his spare

time, believed that the hill was a mass of black oxide of tin, of which he had read in his "Prospector's Guide." He induced two others, David James and James Poole, engaged in dam sinking on Mount Gipps, to join him. They pegged out the first block of 40 acres, subsequently to earn world fame as block 12, on the "broken hill," lodged an application for a mineral lease, and prepared to open up the claim.

Fortunately this incident was to bring on the scene George McCulloch, the brawny, two-handed Scot who managed Mount Gipps. McCulloch was strong of will and body, and grim of humour. He had been heard to threaten he would break the neck of anyone so venturesome as to "peg the hill." Rasp deemed it prudent to say nothing about his "tin" mine to the manager. Better to throw up his job and retire quietly. That evening he rode to the homestead and, acquainting McCulloch with his desire to leave, asked for his pay. McCulloch shrewdly conjectured that the boundary rider must have made a rich discovery. Drawing from him the fact that he, James and Poole had pegged out a block on the hill, McCulloch reminded Rasp that he and his mates had no money, but that he himself had. He suggested that he and the station personnel should join in a syndicate.

THE SYNDICATE OF SEVEN

So that night at Mount Gipps station, the first Broken Hill company, an unregistered syndicate of seven, was formed, comprising:—

Charles Rasp, boundary rider,
George McCulloch, manager,

George Urquhart, sheep overseer,
George A. M. Lind, storekeeper,
Philip Charley, station hand,

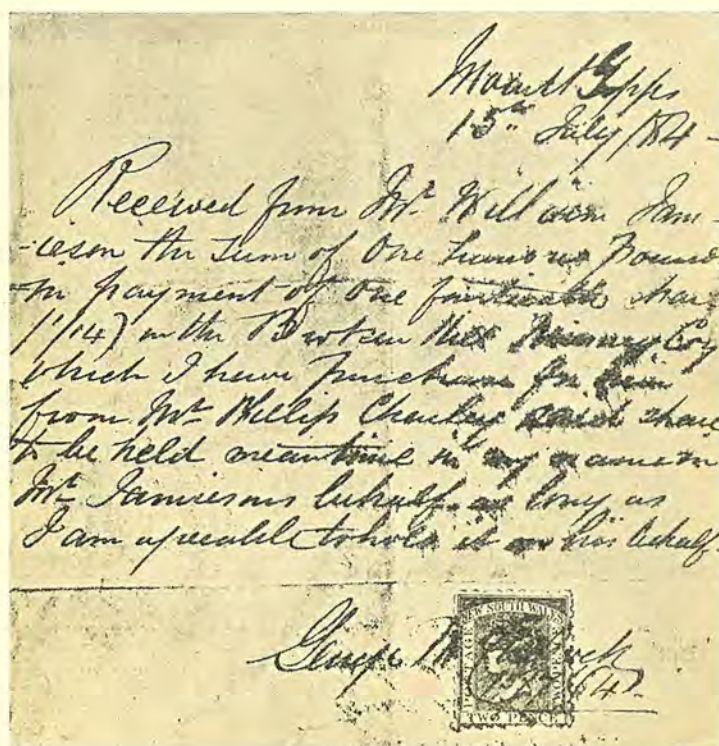
David James, contractor,
James Poole, his mate.

Next morning, McCulloch and Rasp pegged out the remaining blocks on the hill. By September 21, the syndicate had lodged with the warden at Silverton, applications for blocks 10 to 16. Thus was the hill safeguarded against "jumpers" and wandering prospectors. But the Silverton residents scoffed at the hopes of the young syndicate. A "hill of mullock," prospectors had called it, and as such it was contemptuously regarded by the local population. Little dreamed they that Silverton would wane before the progress of the new field.

FATEFUL GAME OF EUCHRE

The sinking of Rasp's shaft produced disappointing results, assays showing only 10 to 12 ozs. of silver to the ton. This considerably damped the enthusiasm of the syndicate. They did not know the shaft had struck the lode at its poorest part. This knowledge only came to them subsequently. In their discouragement the syndicate commenced trafficking in their interest in the mine. Shares and half-shares changed hands. One fourteenth share provided the stake in a game of euchre which has become historic. McCulloch wished to sell half a share for £200, and offered it to a young Englishman, a "new chum" named Cox then visiting Mount Gipps. Cox refused to give more than £120, and challenged McCulloch to stake the result on a game of euchre, the winner to fix the price upon which the share should change hands. McCulloch prided himself on his card play and accepted the challenge. He lost—and with it that fourteenth share which, if held in its entirety, in six years' time, on market values, with dividends and bonuses, could have represented £1,250,000.

The game played that night at Mount Gipps station was for the record stake in history.



JAMIESON'S RECEIPT—
Which Tells Its Own Story.

THE COMPANY OF FOURTEEN

In 1884 a new and important figure in the development of Broken Hill appeared in the person of William Jamieson, a surveyor attached to the New South Wales Department of Mines. Requested to undertake the survey of Broken Hill and Silverton leases, he drove down from Bourke. The whole of the west was gripped by drought, and the story of Jamieson's journey provides an epic of endurance. His entry into Silverton coincided with a downpour of rain. The great drought of 1884, which strewn the west with the carcasses of possibly millions of sheep, cattle and horses, was broken. Jamieson having made the acquaintance of the station group, his interest in the black, burnished hill was roused. He sensed there were greater values concealed than had been revealed by Rasp's shaft, which impelled him to acquire an interest. He bought three shares each of one-fourteenth; two he subsequently sold. By these and other transactions the syndicate of seven developed into a syndicate of fourteen. Urquhart and Lind had grown weary of the disappointments, of the constant financial calls which development was making, and had sold out.

The New South Wales geological surveyor, C. S. Wilkinson, on inspection, held that the crest of the ridge was the outcropping of a huge lead lode capable of supplying all Australia. He considered that further prospecting would prove it a valuable argentiferous lead lode. His cheering report was confirmed later by Norman Taylor, a field geologist formerly of Victoria. The syndicate was stirred to renewed effort and hope.

RICH SILVER CHLORIDES

January, 1885, was a momentous month for the syndicate. Young Philip Charley, on returning from a holiday trip to Melbourne, rode to the hill to note progress. Searching out and picking with his knife at some clumps of ore, he detected grey specks. Recognising these as chlorides, he galloped back to the homestead and displayed his specimens. The assays of up to 800 ozs. of silver to the ton of ore sent the hopes of the syndicate soaring. Then followed a startling revelation. A man named Low handed Jamieson a specimen of ore, remarking: "I found it near your claim." The stone was impregnated with silver chlorides. Some bargaining ensued before Low consented to point out where

he had found the stone. Jamieson judged from the water-worn condition of the specimen that it had been washed down from higher on the hill. Accompanied by a black boy, Harry Campbell, who carried a 16-lb. sledge hammer, he climbed towards the crown of the hill. A great block smashed



WM. JAMIESON
First General Manager of The B.H.P. Co. Ltd.

by the boy revealed the presence of rich chlorides. Subsequent assays, showing over 1000 ozs. to the ton, confirmed the belief that the stone was superlatively rich. The "hill of mullock" stood out as the treasure house of the Barrier which was speedily to enrich surveyor, station manager, station hands, and other lucky holders of the shares. It was to transform that landmark of the saltbush country into Broken Hill and make its name famous throughout the world. Its flow of treasure was to affect profoundly Australian destinies. For over half a century the mine was to link the Age of Silver with that of Iron and Steel.

THE BROKEN HILL PROPRIETARY

The shareholders met at Mount Gipps station and, agreeing to float a company, appointed Jamieson, McCulloch, Bowes Kelly, and W. R. Wilson to draw up the prospectus. Of these, Wilson was the only one with any knowledge of company flotation. Acting on his advice, it was decided to offer 2000 shares to the public of Sydney, Melbourne, Adelaide and Silverton in equal proportions at £9 a share. The terms were £2/10/- on application, £2/10/- on allotment, and the balance in four equal payments of £1 each. When payments were completed, the shares were to be issued as paid up to £19, "for," said Wilson, "if you give them a share worth £19 for £9 it's dirt cheap!"

That same night, June 20, 1885, the first prospectus of The Broken Hill Proprietary Company Ltd. was drawn up. Before dawn of the 21st, copies had been printed on the press of J. S. Reid's newspaper, "The Silver Age."

and that day's coach saw Jamieson on his way to Adelaide with packages of the prospectus stored in the boot of the coach.

The prospectus set out that The Broken Hill Pty. Co. Ltd. was to be registered under the Companies Act, with a capital of £320,000 in 16,000 shares of £20 each, to be issued as paid up to £19. Provisional directors were: George McCulloch of Mt. Gipps station; Bowes Kelly of Silverton; Harvey Patterson of Melbourne; Kenneth E. Brodribb of Poolamacca Station; William Jamieson of Silverton; William Austen Horn and J. W. Bakewell of Adelaide; W. R. Wilson of Silverton; and S. F. Hawkins of Mount Gipps station.

The flotation was successful, all shares being taken up, though they hung fire in Melbourne. Jamieson was appointed general manager and William Knox, of Collins Street, Melbourne, secretary at a remuneration of £1 per week.

Meanwhile discoveries of amazingly rich chloride had been found in the kaolin of Block 12. The ground had been opened up disclosing that the ironstone disappeared at the surface and silver was found in a matrix of kaolin and quartz. Assays went from 1,800 to 3,000 ozs. to the ton. Knox shaft, sunk on this treasure, began the amazing life of the "Big Mine." These discoveries caused wild excitement in and around Silverton, and the Broken Hill diverted to itself the feverish life of the Barrier. The new star of Willyama, the Broken Hill, had arisen.

Under such auspices The Broken Hill Proprietary Co. Ltd. came into being on August 10, 1885. Development proceeded apace. Two 30-ton smelters were installed. At the first general meeting of shareholders the chairman, Mr. A. R. Blackwood, was able to congratulate shareholders on the possession of a silver mine of remarkable richness. The property of the Mount Gipps syndicate had attained to the dignity of a great mine.

Already a town was rising magically at the foot of the hill. In October, 1885, the Government of New South Wales had issued its proclamations under the Mines Act reserving from occupation under miner's right or business licence the very land over which the town was spreading. The line of Argent Street had been defined; hotels and buildings were rising swiftly. The miners decided to go on building and defied the Government.



VIEW OF OUTCROP LOOKING NORTH FROM JAMIESON'S SHAFT, 1886.

Silverton was being depleted of its buildings and population by the new settlement, where, only very slowly, order was being evolved from chaos. Early Broken Hill, due to its shortage of water and neglect of health precautions, was as sickly as any town of the gold rushes. Through those first few years, in its feverish life, excesses, mad speculation, and in the riotous trade of its hotels, it rivalled any of the towns which grew up on gold discoveries. Yet through it all a stream of silver treasure flowed from the Hill. And, as order gradually developed from the confusion of the mining town at the foot of the Hill, so did the progressive development of the "Big Mine" increase.

THE SILVERTON TRAMWAY

Agitation for a railway resulted in the South Australian Government constructing a narrow gauge line from Peterborough, in South Australia, to Cockburn on the New South Wales border, at a cost of £153,569. But a railway terminus at Cockburn fell far short of Barrier needs. The New South Wales Government refused to construct the connecting section. The men of Silverton decided to build the line themselves and floated the Silverton Tramway Coy. with a capital of £50,000. The necessary legislative sanction was obtained in October, 1886, and the line constructed and opened eleven months later, terminating at Broken Hill, and thus giving that centre all the advantages of direct transport to the seaboard for its wealth of silver and lead.

THE BIG MINE

The Proprietary mine continued to grow in richness and reputation. In the first three years from the discovery of the chlorides it produced 7,079,291 ozs. of silver, and 27,988 tons of lead, giving a net return of £1,579,377, with dividends totalling £568,000. The dark bluff above the mulga scrub had been transformed, and the saltbush plain about its base gave way to the clang and clamour at the birth of a great city. The two smelters originally established could not cope with the increasing output of ore, and three more were installed. Chimney stacks, 60 feet high, crowned the hill crest to carry off the fumes from the smelters. Day and night "the Hill" resounded to an army's operations. On the western slope the furnaces glowed through the darkness. It seemed that the treasure which had called these forces into play and a city into being was inexhaustible. American silver experts, engaged by the directorate, reported favourably of the prospects.



THE FLOTATIONS

With the immensity of the ore body recognised, the Proprietary, holding the leases from 10 to 16 inclusive, entered, in 1887, upon a series of flotations of new companies, thus raising capital to ensure development. The first flotation, Block 14, was effected on February 16, 1887. Blocks 15 and 16 were offered on the London market, resulting in the formation of the British Broken Hill Pty. Co.



A. R. BLACKWOOD

First Chairman of Directors of The B.H.P. Co. Ltd.

Ltd. The year 1888 saw the flotation of Block 10. The nominal value of the shares received by shareholders as the result of these three flotations was £1,744,000. This, with £576,000 from the British flotation and profit derived from mine proceeds, increased the value of the 16,000 Proprietary shares to £2,696,000. This was within five years of the time when the shares of the first syndicate were going begging for £100!

Blocks 11, 12 and 13, retained by the Proprietary, were the pick of the Hill. By the magnitude of its ore body, high grade and consequent value, the Proprietary had become the greatest silver mine in the world. In view of the high market value of the original stock it was decided to reorganise the Company by increasing the number of shares from 16,000 to 160,000, thus reducing the value per share from £20 to £2. The shareholders approved (21/2/89) and the shares issued as paid up to £1/18/-. In order that they might be paid up to £2, a call of two shillings was made—the Company's first and only call—and simultaneously a dividend of two shillings was declared.

Jamieson, the Company's first general manager, was succeeded at the end of 1885 by S. R. Wilson. On his resignation in May, 1887, W. H. Patton, of the Consolidated Virginia Silver Mining Co., was appointed. His experience in the mining of large silver lodes and in the control of extensive milling and amalgamating plants was extensive. The Company also engaged H. H. Schlapp, formerly superintendent of the Pueblo Smelting and Refining Works

of Colorado, U.S.A., as metallurgist in charge of smelting operations. Under the guidance of these two, important progress was made, and Patton's first report was the prelude to important developments in mining methods at Broken Hill.

DISABILITIES DUE TO DROUGHT

Drought conditions at the Hill seriously prejudiced mining operations, even menaced the town itself. The drought of 1888 was followed by that of 1891-2. Water for domestic purposes had to be purchased from the South Australian Government's tank at Mingary, 70 miles away, and but a scant supply was obtainable. The mining companies were pumping water from wells sunk on the Acacia eight miles away. The Government would do nothing and the Minister responsible, F. W. Abigall, was burnt in effigy. The Broken Hill Water Supply Co. was formed and stepped into the breach. By May, 1892, the storage reservoir built at Stephen's Creek was completed. Almost coincidentally rain fell over the 170 square mile catchment area of Stephen's Creek and the reservoir received 500,000,000 gallons, about one-eighth of its capacity. Drought, which had threatened to destroy the great community about the Broken Hill, was thus overcome.

THE GREAT STRIKE

But a further menace was rearing its ugly head. The late eighties and early nineties were years of acute depression and industrial unrest. The various unions having grown in power, both industrial and political, were anxious for a trial of strength. Amongst the most militant was the Amalgamated Miners' Association, then insisting upon its claim for preference to unionists. The



OLD 30-TON SMELTERS ABOUT 1887.

Barrier branch of the A.M.A. differed from the mine owners and tests of strength were made in the ten days' strike (Nov., 1889) and the four weeks' strike (Sept.-Oct., 1890). The former was based on the preference question, the latter upon the restricted mining operations due to stock accumulations during the maritime strike. But the supreme test lay in the great strike of 1892.

With the drop in silver prices and the need of more economical working, the Broken Hill companies decided to be bound no longer by an agreement made with the men in 1890, especially a certain clause 4, which restricted the stoping of ore by contract. The Companies were impelled by the disproportionate cost as between man and man, in raising the ore, the lack of incentive to effective work essential to the life of an industry, the drop in silver, the general reduction in values of ore, and the import duties on mining requisites. To forestall the mine-owners, 6,000 men met (3/7/92) and decided on an immediate strike, which lasted until November 8. It was marked by serious disorders, reaching a climax on August 25, when the Companies decided on re-opening the mines. The New South Wales Government at length intervened. Seven strike-leaders were arrested and tried for having "conspired to prevent subjects of the Queen from following their lawful occupations." Six were convicted and sentenced to terms of imprisonment varying from two months to two years. Peace reigned on the Barrier for the ensuing decade.

THE OPEN CUT

In 1890 Mr. Patton resigned from the post of General Manager, being succeeded by Mr. Howell of American experience in winning, concentrating and smelting ores. To Howell fell the task of pressing forward with the great open cut scheme, originally recommended by W. R. Wilson. This scheme provided for removing a portion of the outcrop, thereby relieving the strain on the underground workings. The outcrop, however, contained valuable proportions of lead and silver and the Company eventually decided to carry the cut throughout the entire length of the property. Within 15 years the cut was nearly 300 feet in depth by 4,000 feet in length, and from it had been lifted 4,145,756 cubic yards of material yielding 1,409,833 tons of ore. With the completion of the cut the Proprietary largely depleted its supply of oxidised ores.

Mr Howell found an impression existing that the dividend-paying life of the mine would end when ores of the grade and character then being worked became exhausted, despite the fact that there might be still remaining in the mine, in addition to the enormous bodies of sulphide ores already disclosed, vast quantities of dry siliceous oxidised ores containing some lead, but not fit for smelting.



THE OPEN CUT, 1896.

He set himself to discount this idea, pointing out that it was not so much the grade of these ores, as their character, which excluded them from the existing processes of reduction.

Simultaneously with a scheme for an increased water supply Howell recommended the erection of extensive reduction works so that milling and concentrating might be conducted on a scale commensurate with the mine's capabilities.

DISASTROUS FIRES

Extending over approximately eleven years (1895-1906), there was a series of destructive fires underground. The dryness of the ground increased the inflammability of the forest of oregon timbers used in the square-set system of timbering. Heroic fights were waged by officials and men in efforts to save life and property. Unhappily, they were not entirely successful. Ultimately the fires were substantially controlled by the building of brick walls, the cutting away of sections of timbering, and the establishment of water curtains to check the spread of the flames.

THE SMELTERS

The original smelter installation of two 30-ton furnaces grew to a plant of fifteen 80-ton smelters, capable of reducing about 4,500 tons weekly. Concurrently with this development the Company, which, during its first four years, had shipped its products to Europe as silver-lead bullion, decided to establish its own refinery.

So Port Pirie, away in South Australia, 282 miles from Broken Hill, commenced to develop into something more than a mere wheat-shipping centre. From mangrove swamps grew a prosperous seaport town, and from the Proprietary's refinery developed the Port Pirie smelters. Part of the bullion raised from the mine was shipped to England, the remainder being sent to the refinery, designed by H. H. Schlapp, and erected at a cost of £22,489. It was capable of treating from 400 to 500 tons of silver-lead bullion per week. The method employed was that invented in 1850 by Alexander Parkes, of Birmingham, and was based on the fact that molten zinc has a strong affinity for gold and silver, and, under favourable conditions, will unite with them and form an alloy. The zinc is then readily separated from the gold and silver by distillation. The process, as developed from the Parkes system, afforded a ready method of separating those metals from the lead.

During the early years of operations the silver was sold in the Australian colonies by tender, being purchased ordinarily by the Australian banks. The soft lead was shipped to England and China.

PORT PIRIE

PORT PIRIE'S association with the smelting industry began in 1889, when the works erected by the British Broken Hill Pty. Co. were first put into operation. This plant was acquired by The Broken Hill Pty. in 1892 and run in conjunction with the Broken Hill Smelters; in 1897 it was decided to abandon smelting at Broken Hill and new smelters were erected at Port Pirie. Completed towards the end of that year, the new works provided for the treatment of The B.H.P. Co.'s lead concentrates and also for part of the production of certain other of the Broken Hill Companies.

Early in 1914 the Broken Hill South and the North Broken Hill Companies, which up to this time had been shipping their lead concentrates overseas to continental buyers, opened negotiations with The Broken Hill Proprietary Company relative to an amalgamation of interests in connection with the smelting of concentrates at Port Pirie. These were abandoned owing to the inability of the parties to agree.

Upon the outbreak of the Great War in August, 1914, what had previously been mainly a question of expediency assumed the aspect of urgent national necessity, viz., freeing the Broken Hill silver-lead industry from foreign domination and implementing in full measure the expressed policy of the Federal Government in regard to the future of the Australian base metal industry.

The first essential being to make available permanent smelter facilities for the Broken Hill output, negotiations on behalf of the North Broken Hill and the Broken Hill South Companies were re-opened with The Broken Hill Proprietary Company for the purchase of the Port Pirie smelting works. These resulted in an acceptable basis for the acquisition of the smeltery, and on the 7th May, 1915, The Broken Hill Associated Smelters Proprietary Limited was formed.

The nominal capital of the new Company at its inception was £750,000 in £1 shares, of which £600,000 was subscribed, the shareholders being:—

The Broken Hill Proprietary Co. Ltd.	£200,000
The Broken Hill South Mining Co. (No Liability)	£200,000
North Broken Hill Limited	£200,000

The Zinc Corporation Limited immediately afterwards became associated with the new company, taking up 100,000 shares of £1 each, and in May, 1917, the British Broken Hill Proprietary Company took up a share interest of £30,000, bringing the subscribed capital to £730,000, while the nominal capital was increased meanwhile to £1,000,000. A condition of the amalgamation of these interests was that the participating companies should enter into an agreement with The Broken Hill Associated Smelters Pty. Ltd. for the sale of their output of lead concentrates for 50 years.

At a later date, the Sulphide Corporation decided to discontinue smelting at their Cockle Creek N.S.W. works, and send their concentrates to Port Pirie for treatment.

In recent years, changes have taken place in the share-holding interests of The Broken Hill Associated Smelters Pty. Ltd. In January, 1923, the undertaking of the British Broken Hill Proprietary Company was acquired by North Broken Hill Ltd., thus vesting in the latter the former Company's share-holding (30,000 shares) in the Smelter Company. In July, 1925, The Broken Hill Proprietary Company sold its interest (200,000 shares) to the remaining three participating Companies, thus terminating its long direct association with the lead smelting industry, first as sole and later as part proprietor of the Port Pirie Works.

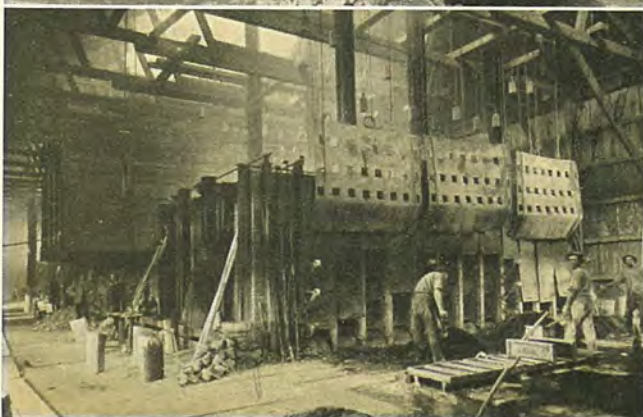
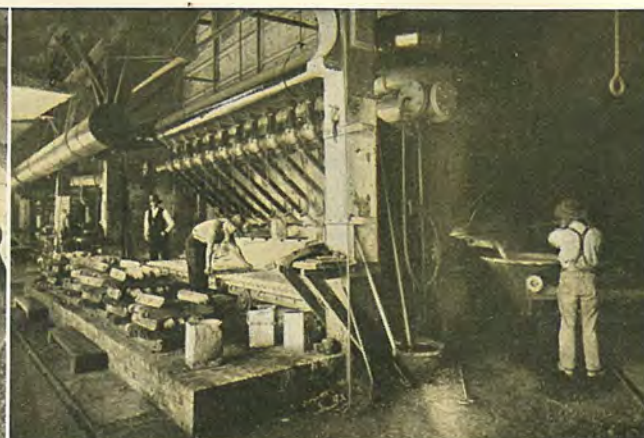
These transactions have vested the ownership and control of The Broken Hill Associated Smelters Pty. Ltd. in the three leading mining companies now operating at Broken Hill (North, South and Zinc Corporation Ltd.), their respective holdings being: North Broken Hill Ltd. 300,000 shares, Broken Hill South Ltd. 245,000 shares, and Zinc Corporation Ltd. 185,000 shares, totalling 730,000 shares.

MODERN PLANT AND EQUIPMENT

During the latter part of the Great War, the Smelters embarked on an extensive programme for the reconstruction and modernisation of the Port Pirie Works, which was completed during 1934.

The first work of magnitude undertaken was the electrification of the smeltery. A modern central electric power plant with distribution network was installed to supply electric power and high and low pressure air to every plant. Prior to this, steam power had been employed and each department had a separate unit. Later an electrification scheme on the water-front was proceeded with and five electric travelling cranes installed to handle inward and outward cargoes—coal, coke, lead, ores, fluxes, etc. The next major electrical undertaking was the installation of an overhead telfer plant for transportation of materials to the blast furnaces.

Shortly after the commencement of erection of the power plant, the transport service was re-organised. Locomotive traction was installed to replace, to a large extent, horse transport, and nine or ten years ago the transportation service was augmented by a motor fleet. Three years later a new modern engineering shop was erected on the site of the old workshop, equipped with the latest machinery of a capacity to handle the whole of the works maintenance and constructions.



Top, left: Blast Furnaces, feed floor; "Banana Carts" in operation.
Bottom, left: Zinc Distillation Furnaces; Charging Furnace.

Top, right: Blast Furnaces, bottom floor, running off slag.
Bottom, right: Zinc Distillation Plant, Prolongs in position.

Very extensive structural, machinery and plant reconstruction has been effected during the past 12 years, the programme having been directed to take full advantage of the marked advance in lead metallurgy due to the success of the experimental and research work of the Company's technical staff. The outstanding feature of these advances has been the development of continuous processes for all stages in the refining of silver-lead bullion.

ORE AND MATERIAL TREATED

The greater portion of the lead ore treated at Port Pirie is derived from the Broken Hill mines. In addition, small parcels of concentrates, sulphide and siliceous lead bearing ores are received from various mines throughout the Commonwealth.

The ores treated are grouped into three main categories:—

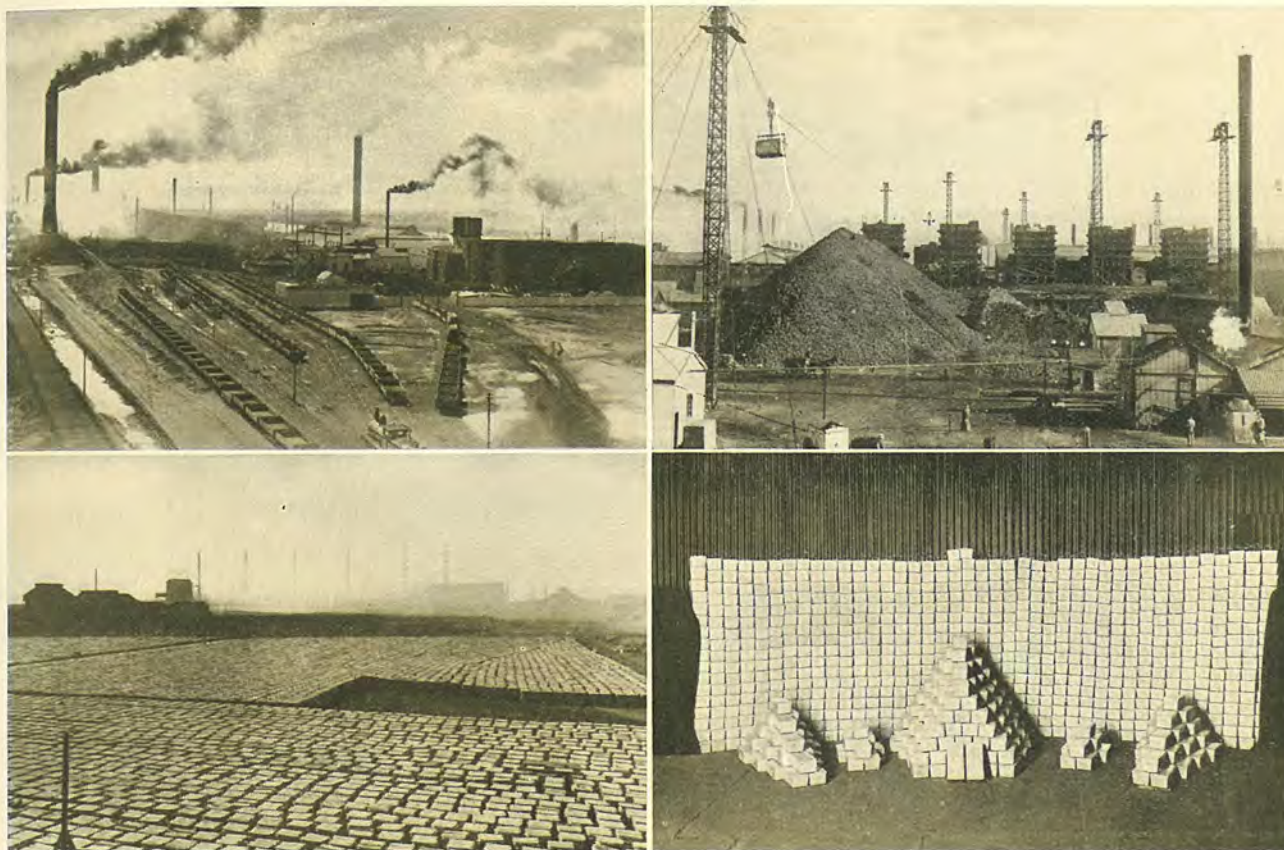
- (a) Granular Concentrates: The product of jigs and Wilfley tables.
- (b) Slime Concentrates: The product of flotation units.
- (c) Siliceous Ores: Received in the crude state. These are crushed at the works, so that the bulk of the material passes through a $\frac{1}{4}$ -in. mesh screen.

Practically all of the lead contained in Broken Hill concentrates is present as lead sulphide, commonly known as galena.

It is not commercially practicable to recover lead and silver from lead concentrates by direct smelting in the blast furnace, because of the presence of sulphur content, and also because of the fine state of division. The first step in the treatment is largely to remove this sulphur by a roasting process, and since the charge must also be agglomerated (sintered), the roasting process is especially adapted to bring about both results.

The roasting is done on Dwight-Lloyd roast-sintering machines, after the addition of certain flux reagents. These machines deliver a product from which the bulk of the sulphur has been eliminated, and which is now in the form of a strong lumpy sinter.

The next step is the smelting of this sinter in the blast furnaces. The essential function of these furnaces is to reduce the oxides of lead produced in the roasting process to metallic lead, and to separate this lead from the waste part of the materials charged into the furnaces. The charge to the



Top, left, Concentrates unloading at reserve dump.
Bottom, left: Lead for munitions, 70,000 tons.

Top, right: Flying-fox delivering coke to storage pile.
Bottom, right: Refinery, 1,000,000 ozs. of silver.

furnace consists of sintered material, certain smelter by-products and the coke necessary to bring about the fusion of the charge and the reduction of the lead and silver to the metallic form.

The furnace products are lead bullion, containing practically all the silver that was in the charge and any gold present, and such impurities as copper, antimony, arsenic and slag, which contains the waste materials of the charge. Both lead bullion and slag are tapped from the furnace in the molten state, each through its special taphole—bullion going to the Lead Refinery; slag to the waste dump.

The Lead Refinery, which is unique amongst the refineries of the world, was designed as the outcome of much research by the B.H.A.S. staff. It covers a very small area in relation to its output, and is the only refinery in the world in which a continuous-flow refining process is operated.

In addition to these, the residues resulting from the Electrolytic Zinc Co.'s operations at Risdon are treated for recovery of the lead and silver contents.

The first treatment of these ores is a preliminary roasting, carried out on seven straight line standard Dwight-Lloyd machines. The conveyors delivering the charge to the machines from the supply hoppers are direct geared to the machines and deliver the charge to the pallets by means of oscillating chutes working transversely. The product is then crushed, and after that a final roasting takes place. The capacity of the smelters normally is approximately 200,000 tons of lead and 8,000,000 ozs. silver per annum.

THE BELLAMBI COKE OVENS

The Port Pirie Smelters demand coke on a large scale. At the outset, this was obtained from outside manufacturers, but the Proprietary decided to erect and maintain its own coke ovens, which would make operations independent of outside supplies, provide for continuity of working and ensure coke of the standard most suitable for requirements.

Bellambi, in New South Wales, was selected as the site for the new enterprise, and construction began late in 1900. Contracts for coal supplies were entered into and building operations went on apace. Within twelve months the plant was in production. For some fifteen years coke for all Broken Hill Proprietary requirements was obtained therefrom. Then the Company disposed of its interests in the Port Pirie smelters to The Broken Hill Associated Smelters Proprietary Ltd., and included in the transfer was the coke oven plant at Bellambi.



BROKEN HILL—New Extraction Processes

THE SULPHIDES

MORE than smelting was necessary if benefit were to be derived from the extraordinary variety of ores existing. An ore-dressing plant, erected at the Hill in 1889, proved unsatisfactory owing to serious losses in the "tailings." Remodelled and enlarged, however, it became capable of treating weekly 1,500 tons of carbonate and sulphide ores with the prospective recovery of two-thirds each of the silver and lead. The Company then decided to open up the sulphide ore zone of the mine, and the chairman, Mr. D. E. McBryde, informed shareholders (8/8/95) that the future prosperity virtually depended upon the sulphide ore. By 1897 there was in commission a concentration plant, subsequently extended to a 10,000-ton weekly capacity, designed to produce a high-grade lead product and a high-grade zinc product with "tailings" considered to be of little or no value.

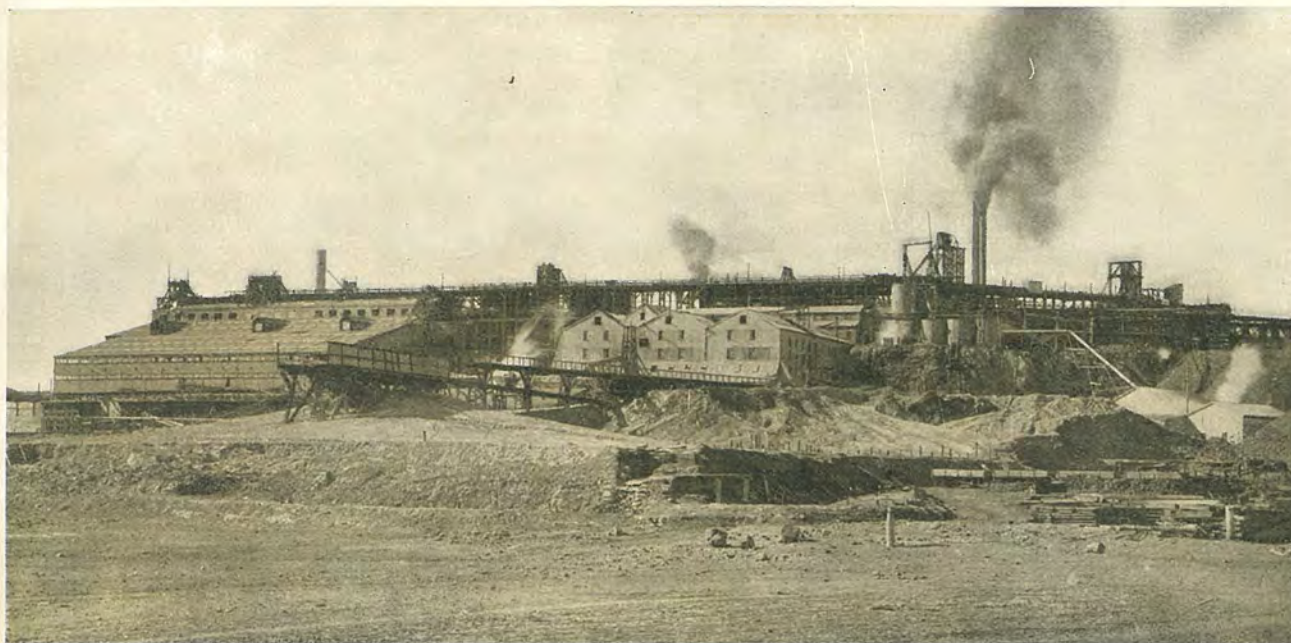
During these years, Howell, Alexander Stewart and G. D. Delprat successively occupied the position of General Manager. G. D. Delprat had been appointed Assistant-Manager in 1898, and was promoted in April, 1899. In April, 1893, Wm. Knox resigned as Secretary, and F. M. Dickenson, who had been Assistant Secretary from 1888, succeeded to the position.

Mr. Delprat was a native of Holland and enjoyed an international reputation in the metallurgical and mining worlds. One of his first acts as general manager was to draw attention to the "tailings" which contained enormous quantities of zinc, and he directed efforts for its recovery. Delprat and the Company's metallurgist, A. D. Carmichael, gave themselves to the problem and the directorate was able to announce (30/1/1903) that experiments were likely to be successful, and that probably a million tons of tailings at the mine could be treated in addition to large quantities being produced.



THE FIRST FIFTY TONS OF CONCENTRATES PRODUCED AFTER THE DISCOVERY OF THE FLOTATION PROCESS AT BROKEN HILL, IN 1903.

At the back: M. Petch, Foreman Tinsmith. From the left: E. T. Henderson, then Assistant Metallurgist; Leslie Bradford, Metallurgist, now General Manager, The Broken Hill Proprietary Co. Ltd., discoverer, in conjunction with A. D. Carmichael, of the Flotation Process; J. A. Lindsay, Chief Engineer, now Inspecting Engineer (Adelaide); G. D. Delprat, General Manager; R. Spier, University Student, acquiring experience at Broken Hill during vacation; E. J. Horwood, Works Manager, now B.H.P. Superintendent of Mines; C. G. Hylton, then Mill Superintendent.



ORE DRESSING MILLS AND DELPRAT SHAFT, ABOUT 1910.

A series of unsuccessful attempts had been made before a chance discovery by Delprat showed that separation had been effected by flotation. He reported his discovery to the directorate, showing substantially increased recovery of zinc, silver and lead in the original middlings. He also urged that patent rights be secured immediately as he considered the process was applicable to sulphides other than blende. From the "Prop" mine the output for the half-year ended May, 1904, was 287 tons of zinc concentrates from 868 tons of tailings. The next six months produced 8,105 tons. Each year showed an increase until, in 1911, it amounted to 93,302 tons. By that time 1,750,000 tons of tailings had returned 500,000 tons of zinc concentrates.



SLAG DUMP, 1918.



THE PRODUCTION OF SPELTER

Having established the production of zinc concentrates, the Company faced the problem of marketing the product. In June, 1904, the first sale of zinc concentrates was made, prices varying from £2/12/6 to £3/7/6 per ton. Other companies on the Barrier having adopted the flotation process, the output was increased considerably. In view of the rapidly expanding production of zinc concentrates (it grew from 103,665 tons in 1906 to 506,680 tons in 1913), the Company decided to erect a plant at Port Pirie for the production of spelter. An experimental plant not proving successful, Mr. Delprat travelled abroad and, as a result of investigations in America and Europe, recommended the erection of furnaces of the Paul Schmidt and Desgraz, or Rhenish, type.

In May, 1908, the first unit of the spelter works was completed. The Company then decided to add another nine furnaces, at a total cost of £100,000. These furnaces would produce, annually, 8,000 tons of spelter, for which there was a market in Australia and the East.

THE BRADFORD PROCESS

The Delprat process did not differentiate between the sulphides of the various metals contained in the ore, but floated them as a whole. This limited its use to ore in which one sulphide predominated. The slime produced in crushing the crude ore contained zinc, lead and silver as sulphides, in about the proportion contained in the crude ore. A mixed lead-zinc-silver concentrate could be produced from these slimes by bulk flotation methods, prior to 1910, but the concentrate was of very little commercial value.

Prolonged experimental work by officers of the Company aimed at separating the zinc sulphide from the lead sulphide. In 1910, this was successfully accomplished by Mr. E. J. Horwood, who obtained a patent for his process. This process took advantage of the fact that the lead sulphide was much more easily oxidised than zinc sulphide, both by the action of certain chemicals and by heat.

The partially oxidised lead sulphide would not float when submitted to flotation treatment, whilst the zinc sulphide did so readily. Mr. Leslie Bradford and Mr. E. T. Henderson were associated with Mr. Horwood in this discovery.

In 1912, Bradford discovered another method of separating these two minerals. This also made use of the fact that lead sulphide was more easily acted upon chemically than zinc sulphide. He used

as his flotation medium a solution of common salt which was slightly acidulated. In this solution the lead sulphide is partly soluble and will not float, while the zinc sulphide, being insoluble, floats easily.

In 1913, Bradford obtained three other patents in connection with flotation. The first was for a soluble mineral frothing agent, which, added to the solution, gave the same result as was obtained by an oil addition. Oil at that time was considered to be indispensable for that type of flotation.

The second patent was for the addition to the flotation circuit of a soluble copper salt to enhance the floatability of sulphides. It is now generally recognised that sulphides coated with copper sulphide are less soluble in flotation circuit liquor than the uncoated sulphides. Since the more insoluble a particle is, the more easily it floats, the advantage of using a soluble copper salt, which causes this coating to be produced, is readily understood. Unfortunately, Mr. Bradford patented this process in Australia only, for it is now the most widely used flotation re-agent in the world.

The third discovery of Bradford's in 1913, was that zinc sulphide could be prevented from floating if the circuit liquor contained either SO_2 or a salt capable of liberating SO_2 . This discovery enabled the oxidised slime which was contained in the dumps to be readily and cheaply treated. The lead sulphide was first floated and carried with it the silver, the zinc sulphide being retarded by the SO_2 . Then by getting rid of the SO_2 , by heating the solution, or by adding copper sulphate, the zinc sulphide could be floated.



MR. F. M. DICKENSON,
Secretary 1893 to 1923.



In 1916 a plant using the above process was started and treated dump and current production slime at the rate of 4,000 tons per week. The products consisted of a high-grade lead concentrate containing 80 to 90 ozs. of silver per ton, and a high-grade zinc concentrate. The residue was very low in sulphides, but contained 9 per cent. of lead, 90 per cent. of which was lead sulphate. This was due to the highly oxidised condition of the slimes treated. The recovery of this oxidised lead from these residues was the subject matter of a great deal of experimental work. It was eventually solved by Mr. E. T. Henderson in 1928 and covered by letters patent.

The plant, which had at this time completed the treatment of the slime dumps, was modified slightly, and the residue from the Bradford treatment was re-treated in it. The lead sulphate was floated off as a 42 per cent. lead concentrate, which was shipped to the smelters.

To Mr. Bradford is due the honour of being the first to discover the use of retarding and accelerating re-agents in flotation. These to-day are the foundation on which numerous flotation processes depend, and by which an enormous tonnage of low-grade sulphide ores is being treated at a profit.



MR. JOHN DARLING.
Chairman of Directors 1907 to 1914.

THE EXPLOSIVES ASSOCIATION

In 1908 a High Explosives Trade Association was formed overseas which entailed an increase of 45 per cent. in the price of explosives. This meant to The B.H.P. an additional annual outlay of £4,500 and a total increase to the various Australian mining companies of £125,000 annually. The De Beers Consolidated Companies in South Africa had been faced with a similar impost, but had countered it through the courage and ability of its chairman, Cecil Rhodes, who was instrumental in having erected a dynamite factory near Cape Town.

The Broken Hill Pty. communicated with the De Beers, and leading officials of that organisation visited Australia. Meetings between them and representatives of Australian mine-owners resulted in the De Beers Co. extending, at considerable capital cost, the Cape Town factory. The negotiations resulted in a five years' agreement on the basis of 12,000 cases a year. The High Explosives Trade Association then made an offer to supply explosives at a "special reduction in price," but met with little success. Thus the sum of £125,000 was saved annually to the Australian mining companies.

THE OVERSEAS MARKET

Between the years 1886 and 1889, output of silver-lead bullion from the Proprietary mine was shipped to London. The first loading, per s.s. "Shannon," transhipped to the s.s. "Oceana," comprised 164 tons and realised £10/9/10 per ton. The Company also opened up trade with the East for its lead. From a small beginning this trade grew rapidly. By 1892 the East was taking 8,000 tons as against 2,800 tons sold to London. In 1899 export of our lead to the East had grown to 9,500 tons, whilst by 1911 it had grown to 30,000 tons per year.

A change in the overseas lead selling policy became necessary in 1908, due to the fluctuation of the European market. To ensure stabilisation a world-embracing lead convention was formed, all lead shipments being sold through an individual English firm of metal brokers. The convention was directed by a committee representative of the producers. The Great War put an end to this arrangement, the vast overseas market built up by The B.H.P. being seriously deranged.



SUBSEQUENT OPERATIONS AT BROKEN HILL

Ore-extraction at the Broken Hill mine was beset with adverse factors, industrial and economic, that led to a chequered career in later decades, with periods of suspension, unprofitable operation and eventual closing down. Prior to 1908, the only serious interruptions were due to strikes, with short stoppages arising from water shortage and underground fires.

The period of greatest productive activity was from 1900 to 1908, during which, following the duplication of the ore dressing mills, tonnages up to 13,000 tons of ore per week were extracted, a figure considerably exceeding that of any other Barrier mine, either before or since.

Early in 1909, industrial disputes led to a suspension. Owing to high wages, low metal prices and high costs of production, the reopening of the mine, except at a loss, was impossible. In 1911, mining was resumed on less than half the previous scale, profitable working having been made possible by improved metal prices and concentration upon the more easily worked portions of the mine.

From then on operations proceeded continuously until May, 1919, when work at all the Barrier mines ceased as the result of further industrial trouble. Early in 1921, after a trial period of two months, it was found impossible to continue, except at a serious loss, and the mine was shut down.

The scattered nature of the available ore bodies and the large extent of drives and crosscuts to be kept in repair, combined with low metal prices, prevented the carrying on of any work except the re-treatment of slimes and tailings dumps, until towards the end of 1923, when community treatment of ore from Block 14 and the Proprietary mine was inaugurated. Reduced working costs, tonnages augmented by output from the re-purchased Block 10 mine, and improving metal prices enabled operations to be continued satisfactorily until September, 1927, when low metal prices again prevented profitable working. The mine remained shut down until September, 1929, when arrangements were made for the treatment of our sulphide ore and that of Block 14 Company at the Sulphide Corporation mill, which was enlarged to cope with the consequently increased tonnage.

This arrangement continued until June 30, 1930, when, owing to the fall in metal prices and the expiration of the contract with the British Board of Trade for the purchase of zinc concentrates, the mine was again closed down. Operations have since been confined to safeguarding the property and keeping the mine unwatered.

Production Figures of the Broken Hill mine since commencement of operations are :

Ore Mined	11,959,519 tons	Gold, fine	117,793 ozs.
Lead	1,396,558 "	Antimonial Lead	13,323 tons
Zinc	600,637 "	Copper	4,576 "
Silver, fine	185,611,139 ozs.		



TRANSITION TO STEEL

PRELIMINARY PRE-WAR MEASURES

BY a singular stroke of fortune for the Commonwealth during the war years, The Broken Hill Proprietary had established the Newcastle iron and steel works, the necessary ore coming from the mountains of Iron Knob and Iron Monarch, 33½ miles inland from the tiny port of Hummock Hill, on the western shore of Spencer's Gulf, in South Australia.

Rising black above red sandy plains covered with myall, mulga and salt bush, the Monarch and the Knob suggested resemblance to the Broken Hill itself. Metallic indications, which were known last century to the station hands of Coruma and Middleback, became significant in the light of the wealth of Broken Hill. In the hope of silver, a syndicate was formed and shafts were sunk at the base of the Monarch. Samples of ore were shipped to England for assay. Results disclosed iron but no silver. Disgusted, the syndicate disbanded and allowed their leases to lapse.

Seeking ironstone flux for the Port Pirie smelters, The B.H.P. acquired from the South Australian Government a lease of 360 acres over Monarch and Knob. The ironstone was used regularly for the smelters. By 1911 a total of 600,000 tons had been consumed. Experimentally, in 1907, a quantity of ore was smelted at Port Pirie and cast into pigs, five tons weight of them, which were sold at £5 per ton and pronounced of excellent quality. Three years later, H. L. Y. Brown, Government Geologist of South Australia, reported that at the Iron Knob and Iron Monarch a vast quantity of iron and manganic iron ore was in sight. This he placed at 21,000,000 tons. Its magnitude and importance, he added, had, so far, been unequalled in Australia.

INVESTIGATING POSSIBILITIES

The abundance of the iron ore and its high grade influenced the directorate, John Darling then being chairman, to the decision of sending Delprat to Europe and America to confer with the greatest known experts upon the practicability of establishing iron and steel works, to be supplied with ore from Iron Monarch and Iron Knob. At a half-yearly meeting of shareholders (5/8/1911) it was announced that the general manager was to acquire the latest information abroad and, if necessary, secure the services of experts for the development of industries kindred to the Company's resources. In February, 1912, the chairman reported that the general manager had visited the U.S.A., and was then in Europe collecting the information indicated. Probably, he stated, he would bring an expert with him, as, in view of the ironstone deposits which they held and the fact that the Commonwealth's requirements of steel rails would be very large for the next few years, the Board had thought proper to make complete investigations with the thought of extending the Company's operations.

Mr. Delprat visited iron and steel works in America, England, Germany and Sweden. In America he engaged Mr. David Baker, consulting engineer of Philadelphia, to visit Australia and advise the Company. The choice proved a very happy one. On his return to Australia, the general manager reported strongly in favour of the projected enterprise.



MR. G. D. DELPRAT,
General Manager 1899 to 1921.

Mr. DAVID BAKER REPORTS

Arriving in Australia, Mr. Baker, destined to play an outstanding part in the history of the iron and steel industry of Australia, proceeded at once into exhaustive examination. The results were embodied in a report (29/6/12), the terms of which were highly encouraging as to the prospects of success in an Australian market then importing steel to the annual value of £6,000,000.

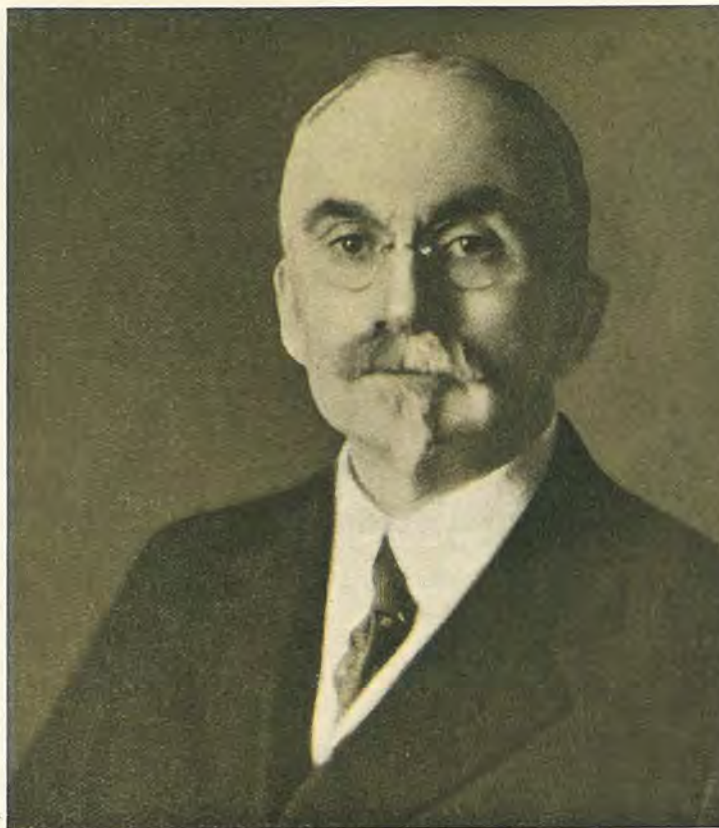
He reported, at Iron Knob, a deposit of high-grade ore admirably suited to steel making. Limestone at Wardang Island, controlled by the Company, offered abundance of flux, and for fuel, large deposits of low sulphur coal, of good coking quality, existed in the neighbourhood of Newcastle. He recommended the carriage of the ore to the coal at Newcastle. The Company's land at Port Waratah, acquired in 1896 as a site for smelters, had a good water frontage. In 1910, 150,000 tons of rails had been imported. The Proprietary, undertaking nearly that tonnage, needed to install a 350-ton blast furnace, three 65-ton open hearth steel furnaces, a bloom mill and heavy rail mill, with by-product coke ovens to supply coke for the blast furnaces. With the rail mill in operation, doubtless, the Company would decide to build a sheet and wire rod mill and wire plant.

The enterprise, which was speedily to prove of national importance, commended itself to the sound judgment of Mr. John Darling, chairman of directors, and made strong appeal to shareholders. At meetings held on September 27 and October 14, 1912, they armed the directorate with full authority to engage in the steel industry and to raise new capital. On January 3, 1913, Mr. Delprat and his staff of skilled officers, drawn from Broken Hill, entered on the task of reclaiming the swamp lands of Port Waratah as a site for the steel works. The Company's 24 acres had been extended by the purchase of another 110 acres freehold in 1912 and 96 acres acquired from the New South Wales Government under the Newcastle Iron and Steel Works Act of 1912-13, which also granted a 50 years' lease of a water frontage of 34 acres. The New South Wales Government undertook to dredge and maintain a channel between the works and the sea, 500 feet wide and 25 feet deep at low water. The holdings of Newcastle lands have since been extended to 1,225 acres.

CONSTRUCTION OF THE STEEL WORKS

A strip of fairly high ground had been used for the old copper smelters at Port Waratah, on the upper reaches of Newcastle harbour. But mangrove swamps and mud-flats, three feet under water at high tide, mainly offered for the steel works site. Powerful plant was assembled and an army of workers engaged, the preparation of the site going ahead with speed. Government dredges at the frontage brought the river depth from 10 feet to 25 feet, the sand being pumped into the swamp. Pile-drivers worked over the mud-flats. Nearly 600 piles, 30 feet in length, were driven for the site of the blast furnace and the heating stoves. Steam-driven mixers supplied cement for the beds. A steam travelling crane, capable of a 60 tons load, was set up on a wharf, built for the reception of the heavy plant, and connected with a railway for transport of plant to its prepared site.

Mr. Baker had returned to America to plan and purchase plant, according to his original recommendation. He returned to Australia in April, 1913, to direct its reception and erection. The first shipment of machinery, received on January 1, 1914, was succeeded by a series of shipments, till, by June, practically all the plant was assembled, and had been, or was being, set up under direction of Mr. Baker, who became its first manager. During the period of erection, about two years, he was



MR. DAVID BAKER,
First Manager of the Steelworks.



assisted in construction and control by Mr. J. McMeekan, ex-manager of the Company's Bellambi coke ovens, as superintendent of construction, Mr. J. A. Lindsay, chief engineer of the Broken Hill mine, as chief engineer, and Mr. J. Bristowe, chief accountant at Broken Hill, with American and English superintendents of departments, supported by a number of skilled American steel-workers, who were to train the Australians. To ensure continuity of ore supply, the works at Iron Knob were being developed by the opening up of new mines and by the construction of bins and loading jetty extension at the port of shipment. By May, 1914, the Company had spent over £500,000 on the steel works and its sources of supply.

The Broken Hill Pty. suffered grievous loss by the death, on May 27, 1914, of Mr. John Darling, whose forceful personality and energetic mind had contributed substantially to the launching of the steel works. It is to be regretted he was not spared to see the fruition of his and others' efforts.

By July 6, 1914, The Broken Hill Pty. issued a prospectus giving details of the proposal to offer £600,000 of 6 per cent. 20-year debentures for public subscription. The issue, to raise capital for completion of the steel works, was part of an intended issue of £1,000,000. The Commonwealth Bank, by arranging for the underwriting of the amount, and receiving applications from the public, entered on a new phase of business. Sir (then Mr.) Denison Miller, governor of the Commonwealth Bank, was solemnly warned that this association with an industrial venture was a departure from the tradition of strict banking practice. The Broken Hill Proprietary had provided for its £1,000,000 within two hours.

By the outbreak of war on August 4, 1914, construction of the steel works had advanced so far that not even the world confusion and consequent dislocation of shipping could hold up the great enterprise. Chief difficulty lay in the non-delivery of Belgian bricks and coke ovens plant, which, happily, was overcome.

The long wharves for receiving and storing ore were constructed and equipped with a Hoover and Mason bridge unloader, and boilers, power plants, and a saltwater circulation system were installed. A rail system, with locomotives and cranes, pig-casting machine and pig iron storage yard were also established.



PORT WARATAH SWAMP IN 1913—WHERE THE STEEL WORKS NOW STAND.



DEVELOPING IRON KNOB WORKS

Over at Iron Knob another mine had been opened, 987 feet above sea level. The ore, blasted from the face, was hand-loaded on to five-ton waggons and by a gravity inclined tramway shot down to the main bin on plain level. Thence it was railed to Hummock Hill. Two 70-ton locomotives were provided for the heavier haulage, and the tramway was reconstructed with 80-lb. track work. Plant at Hummock Hill comprised a nest of five 30 x 18 inch jaw crushers, a storage bin of 15,000 tons nett capacity, and a jetty extended to 900 feet. The ore was passed over a system of conveyor belts from crusher to storage bin and thence along the jetty for discharge into the ship's hold. Power plant of 1,000 k.w. capacity supplied driving power for crushers and conveyors. On January 8, 1915, the steamer "Emerald Wings" (later purchased by the Company and re-named "Iron Baron") received for Newcastle 2,800 tons of ore over the conveyor belts within 3½ hours. This was then a record for Australia.

This was the first ore for the steel works and enabled the blast furnace to be "blown-in" in March, 1915, which meant that the great works, hitherto inert and dumb, had quickened into life. Pig iron was produced and accumulated to allow the starting of the open hearth steel furnaces. On April 9 the first steel ingots were produced for rolling into blooms and billets, and the first rail was rolled on April 24. The Company had contracted to supply 4,500 tons of steel rails to the New South Wales and the South Australian Governments.

WAR AND STEEL

At the official opening of the steel works by the Governor-General, Sir Ronald Munro Ferguson, on June 2, 1915, there were many representatives of political, industrial and social life of the nation. Guests were received by Mr. D. E. McBryde, chairman, and his fellow directors, with Mr. Delprat and Mr. Baker. The nature of the achievement and the future of the steel works were interpreted by the chairman, and stressed by the Governor-General. "The steel products of Newcastle," His Excellency said, in declaring the works open, "will achieve a world-wide reputation." Expenditure on the undertaking then stood at £1,500,000. Of the steel workers 98 per cent. were Australians, who, with intelligence and enthusiasm, were readily acquiring operating skill. By August 27, 32,214 tons of pig iron, giving 17,139 tons of billets and blooms and 11,574 tons of rails, had been produced. Contracts had been made with Federal and State Governments for the supply of 106,000 tons of rails. By the end of October contracts had been secured for another 50,000 tons.

On the formation of the Federal Munitions Committee in August, 1915, the steel works were busy on production of rails urgently needed for Western Front transport, and supply of munition steel for Australian manufacturers, who had contracted to supply shell bodies. The production of steel for these purposes during the war totalled 16,000 tons of steel rails and 16,000 tons of munition steel. Their quality won the high opinion of Imperial authorities.

Facing the rush of orders, the Proprietary developed its plant at a further cost of £500,000, erecting four additional open hearth steel furnaces, with by-product coke ovens and other essential



WATER FRONT, 1914.

plant. Still it remained inadequate to cope with the ever-increasing volume of orders. Blooming and rail mills concentrated on blooms, billets and rails. To meet the shortage, due to war, of structural and merchant steel and wire rod, the Company installed an 18-inch structural mill, 12-inch and 8-inch merchant mill, and a modern Morgan rod mill. A second blast furnace with the necessary additional coke ovens was also planned.

In May, 1916, limestone from Melrose, Tasmania (leased in 1915), was shipped from Devonport to Newcastle. Adequate transport facilities were necessitated by the opening-up of the limestone quarry, the installation of haulage, crushing and power plants, and the erection of storage bins, including

one of 6,000 tons capacity at Devonport wharf. The Tasmanian Government accordingly constructed a railway to replace the old Don tramway to the quarry. At Newcastle the new structural and merchant mills began operating late in 1917. A steel foundry was installed, with a 20-ton acid open hearth steel furnace, for the production of forging ingots and heavy steel castings to meet the requirements of the ever-extending plant.

PLATES FOR SHIPBUILDING

By the end of the year the need for rolling steel plates not only for the Company's second blast furnace, but for the shipbuilding scheme which was engaging the attention of Government and private ship-yards, became insistent. Steel housings, each over 40 tons, were cast for converting the heavy rolling mill into an improvised mill. This enabled the production of 13,000 tons of steel plates, up to 20 feet long by five feet wide, and down to a quarter of an inch in thickness. Production, while the scheme lasted, prejudiced the normal output of this rolling mill.

Industrial troubles on the coal fields from 1916 called for reserves of fuel. Regular blending of coking coal was essential. So, in 1918, the Company built up a storage depot, served by a 200-foot span travelling bridge, capable of dumping 12½-ton coal hoppers, or loading service cars by its grab, from the stock pile. To meet the Federal Government's wish to secure for Australia adequate supplies of foundry iron, the Company erected a small blast furnace, blown-in on July 17, 1918, with a production of 100 tons of pig iron daily. This furnace also smelted manganese ore periodically for the production of ferro-manganese, of which alloy, necessary in refining steel, war had cut off supplies. That year, too, the great engineering shop for the machining of castings and general repairs to plant was established. The Morgan rod mill operated from August 30.

The industry had expanded greatly through the war years, and now subsidiary industries began grouping themselves about the steel works. The Austral Nail Company, which later was to merge into Rylands Bros. (Australia) Ltd. set up its plant for drawing steel wire, and John Lysaght Ltd. established sheet rolling mills. By May 31, 1918, expenditure on the steel works represented £2,862,400.

The end of the war meant that a period of test was at hand for this greatest of Australia's secondary industries. War had eliminated overseas competition; peace allowed it. Yet development proceeded on a grand scale. From December 5, 1918, the second blast furnace, delayed through the war, commenced operations, producing 3,040 tons of pig iron weekly. This was followed by another on August 15, 1921. In keeping with furnace needs, the by-product coking plant was increased to 224 ovens. Plant was installed for the recovery of benzol from coke oven gas. And the Morgan rod-mill was duplicated from a single to a double strand mill. The building of the great block of administrative offices was notable among the developments of the years 1920-22. The Iron Knob leases were supplemented in 1920 with iron ore leases from the South Australian Government of 560 acres covering the Iron Prince and Iron Baron 15 miles from Iron Knob tramway.

CHANGES IN MANAGEMENT

The figure of G. D. Delprat has now passed from the stage of Broken Hill Proprietary activities. In February, 1921, he resigned the post of general manager, which he had held since 1899. He had been an important figure in the transition from silver to steel, and had faced heavy responsibilities in the establishment of the steel works. He had watched their triumphant development according to ordered plan, despite the war, and he had known their national value. Mr. Essington Lewis, later to be created managing director, succeeded him as general manager.

By end of May, 1922, the cost of the steel works, with depreciation deducted, represented £5,783,800.

If war conditions had favoured, post-war conditions certainly prejudiced the Australian industry, which at reasonable rates had supplied the Commonwealth with steel and steel products during the war shortage. Overseas accumulations were now loosed on the Commonwealth. The selling price fell



LUNCH AT THE OPENING OF THE STEEL WORKS, 1915.

through oversea deflation and the lower cost of manufacture. In April and May, 1922, large sections of the Newcastle plant closed down through the severity of foreign competition. On June 15 the Board of Directors made a public statement of the case and of the causes of reduced output and restricted employment. The Company had been forced to decrease the number of its men from 5500 to 840.

During the nine months of this enforced inactivity, the Company sought by every practicable means to counter low-wage overseas competition by increased efficiency of plant and economy of operations.

With slight adjustments of wages and coal charges the steel works reopened in March, 1923. For the year ended May 31, 1923, the production of pig iron had been only 62,344 tons; the following twelve months it rose to 306,256 tons. Development continued with the addition of two 65-ton open hearth steel furnaces, decided upon in 1924, an extension of the Company's fleet for ore shipment, and the all-important decision to develop Newcastle and Maitland coal properties acquired by the Company. This latter decision brought into existence the John Darling and Elrington collieries which to-day are hardly excelled in modern equipment and methods of working.

Through the years of planning and construction, the war, and the fierce post-war competition, Mr. David Baker had played his part as manager with great ability and decision. Late in 1924 he retired from management to enjoy leisure after the intense strain of twelve years of creative effort. He left Newcastle on March 5, 1925, carrying with him universal goodwill and esteem. He was succeeded by Mr. Leslie Bradford, who as metallurgist had discovered and patented flotation processes at the Broken Hill mine, and later, during his association with Newcastle, had won distinction in a series of posts—chief chemist, testing engineer, open hearth superintendent, production superintendent, and assistant manager to Mr. Baker.

THE GREAT COKE OVENS

The group of subsidiary industries was extended in 1925 by the establishment of the Australian Wire Rope Works at Newcastle. New plant increased the efficiency of the steel works — a modern A.C. power plant, comprising two 5000 k.w. turbo-alternator sets, was installed in 1925. The following year a well-equipped fabricating shop was set up with a press which was to produce a heavy tonnage of steel railway sleepers for the North-South Transcontinental line. In 1927 the 8-inch mill was converted into an electrically driven mill. The steel foundry was equipped with a second open hearth steel furnace of 30-ton capacity with electric charging, and in 1928 a new structural steel yard, with flattening and straightening machines, enabled swifter handling and storing of heavy steel products.

In August, 1928, The Broken Hill Proprietary arranged for the construction, at a cost exceeding £1,000,000, of 106 Wilputte coke ovens, with complete coal-crushing and coke handling plant, and apparatus for the recovery of tar, ammonia, and benzol products. This plant was to displace the old Semet-Solvay ovens. In January, 1929, excavations, piling, and concrete were started. By June 20 the space was ready for the contractors. The vast plant of impressive proportions and power was speedily completed, and one battery was brought into commission on November 17, 1930.

THE DEPRESSION

By this time the impact of world-depression, with heavy shrinkage in the national income, was severely felt. Unprecedented difficulties were met in 1930-31, following the collapse in market values of primary production, the cessation of open-market borrowing by Governments, the severely-restricted basis of railway-works, and the loss of purchasing power by primary industries as a



ADMINISTRATIVE, 1920.

G. D. Delprat (General Manager), F. M. Dickenson (Secretary), D. W. Harvey Patterson (Director), Hon. D. E. McBryde (Vice-Chairman), Bowes Kelly (Chairman), H. V. McKay (Director), H. G. Darling (Director), Wm. Jamieson (Director), David Baker (Manager of Steel Works), R. O. Blackwood (Director), F. M. Mitchell (Steel Works Secretary), Essington Lewis (Asst. General Manager).

whole. Orders declined with reduced building and the halt to manufacturing expansion, while the situation was aggravated by coal-prices that had not fallen commensurately with earnings in other industries. Production from the steel works, then just recovering from the disaster of the long stoppage of coal mining, fell to about a third of normal tonnage. With slowly improving prospects, an 18-inch continuous mill was set up and commenced operating on April 13, 1932. The Board also decided to establish a mill to roll plates and remodel the bar section to operate with it. In addition, the Burwood and Lambton collieries were acquired from the Scottish Australian Mining Company.

Orders improved through 1932-33. Advantages from the new coke ovens were definite. The combined 80 in. plate mill and 18 in. tandem mill was completed. Only five months were occupied from the time the old 18 inch mill was shut down until the new plate and bar mill was installed in the existing building. This the directors praised as a remarkable achievement of the technical and constructional staff.

Another rapid stride in construction was the scrapping of the 8 inch merchant mill, which was replaced by a modern continuous 10 inch merchant mill for the production of a wide variety of merchant bar, as well as strip and skelp for the manufacture of pipes.

Meanwhile, Stewarts and Lloyds (Aust.) Pty. Ltd. was establishing its pipe-making plant at Newcastle. This fine new unit went into operation in November, 1934. Skelp for pipe-making was supplied from the new 10 inch merchant mill at the B.H.P. works, which went into commission on January 21st, 1934.

THE RECOVERY

The year 1933-34 reflected the returning confidence of the Australian people. The demand for steel products so increased that the plant resumed normal operations, and by the end of May, 1934, the production of steel ingots exceeded that of the previous year by nearly 100,000 tons. The directorate decided on the most modern type of benzol plant, and to bring the number of open hearth steel furnaces up to ten, with the necessary extension of housing. In addition, a new tar plant went into commission on October 1.

With the activity of production this year, plant improvements include the extension of the stockyards for carrying pig iron and scrap, greater coal storage space, erection of a large gas holder, and new boiler equipment, the extension of the building handling alloy steels, and the manufacture of additional ore cars for Whyalla. At Iron Knob a new bench is being opened up, in this connection further shovels, crushers, etc., being obtained. Reserve stocks, of a large tonnage, of iron ore and limestone at the steel works, are being secured as a national safeguard.

Developed on an orderly far-sighted plan from the unit that served Australia in war-time, the vast plant at Newcastle typifies the national growth. Its fortunes reflect those of the whole country in prosperity or adversity: its expansion connotes a national stature increasing from adolescence to vigorous maturity.

Statistical Data from Inception of Steel Works to November, 1934

PRODUCTION:

Coke	4,420,831 tons
Pig Iron	4,540,047 "
Steel Ingots	4,906,627 "
Blooms and Billets	124,708 "
Rails (all sizes)	1,019,842 "
Structural	441,363 "
Steel Plates	64,106 "
Fishplates and Tieplates	71,824 "
Guardplates	7,066 "
Steel Sleepers	14,209 "
Munition Steel	17,900 "
Merchant Bar	1,197,716 "
Wire Rods	946,977 "
Sulphate of Ammonia	68,851 "
Tar	47,412,746 gals.
Benzol	10,134,920 "
Toluol	372,215 "
Solvent Naphtha	552,794 "
Xylol	3,480 "

TOTAL WAGES PAID:

Steel Works	£18,770,524
N.S.W. Quarries	195,354
John Darling Colliery	696,929
Burwood Colliery	196,883
Lambton Colliery	3,029
	£19,862,719

TOTAL VALUES OF:

All Stores, including Water	£14,300,143
Fluxes and Refractories	749,302
Recarbonisers	1,067,679
Coal used	8,979,971
Purchased Coke	763,026
Ironstone	4,605,939
Limestone	1,314,437
Manganese Ore	68,562



ELECTRIC SHOVEL LOADING IRON ORE



MODERN IRON ORE MINING

Whyalla and Iron Knob

IMMENSE deposits of iron ore about the north of Eyre's Peninsula, roused only two decades ago from the quiescence of centuries, not only present now scenes of amazing industrial activity, but have attracted a populous settlement, whose living conditions and civic amenities furnish an object-lesson and embody the best features of our Australian social system.

Despite water-shortage and an inhospitable landscape originally destitute of trees, the vicinity of the settlements is being steadily transformed by town-planning, skilled arboriculture, the planting of shrubs, gardens, and lawns, and water-conservation. Human welfare is conserved by a liberal housing policy, recreational and cultural facilities, and the fostering of social movements that make for good citizenship and well-spent leisure.

Blasting, crushing, transporting, and loading the ore involve gigantesque operations and the intelligent direction of mechanical monsters. Power-driven machines, mighty crushers and ingenious shovels, automatic conveyors to the ship, afford pictures of stark strength concentrated upon the primary purpose of supplying Australia's supreme secondary industry with its basic material.

For centuries there was dearth of life in any form on this northern strip of Eyre's Peninsula. To-day, a town, planned with foresight and in understanding of and sympathy with the aspirations and the needs of men, has come into ordered being on the shore in the shelter of Hummock Hill. Also at the base of Iron Knob, 33½ miles to the north-west, a smaller township has developed from the original camp. This, too, was designed, as well as were the houses, to counteract all local drawbacks, including the extremes of climate. The national values of the industry founded on Iron Knob and Iron Monarch are more than material.

Flinders visited this portion of the South Australian coast in 1802, but found, as his journals



IRON KNOB TOWNSHIP FROM BENCH D.

show, nothing but disappointment. He put on record, however, that the stone of the district was "argillaceous, reddish, smooth, close-grained, and rather heavy." From the time of his visit, throughout the following century, the rolling plains of the peninsula were held by squatters and supported few inhabitants. They manifested but little interest in its possibilities other than pastoral.

ENORMOUS DEPOSITS

It was not until The Broken Hill Proprietary acquired leases over Iron Monarch and Iron Knob, and their opening up in 1900, that the neighbourhood really came into the picture. Since the establishment of the Newcastle steel works in 1915, the little port at the foot of Hummock Hill has developed into Whyalla, and the camp at Iron Knob has grown into a township of white-walled houses. Plant, which seemed elaborate, and was effective in moving iron ore from the open cut mines to the ships' holds, has given place to, or been absorbed in, plant equal to the production and shipment yearly of the 2,000,000 tons, and more, necessary to feed the Newcastle furnaces and provide supplies for foreign purchase.

The Iron Monarch and Iron Knob leases were supplemented in 1920 by the Iron Baron, Iron Prince, and Iron Queen group, 18 miles south, which form the northern end of the Middleback range. These have since been supplemented by the Iron Knight, Iron Duchess, and Iron Duke group situated some 20 miles still further south. The Iron Baron group was linked (7/6/33) by a branch tramway, leaving the main line between Iron Knob and Whyalla. The heights of the iron ranges are from 1,150 to 1,200 feet above sea level. The Iron Monarch is 640 feet above the plain, its base being $1\frac{1}{2}$ miles in diameter. The bulk of ore contained above plain level is estimated at more than 100,000,000 tons. The estimate for the Iron Baron is equally great, but the reserves of ore in the southern group are not yet fully ascertained. The ore of Iron Knob is hematite, of so high a grade that supplies are drawn from it only for special requirements. The ore of the Monarch is hematite, but with a manganese content, running from one per cent. to a grade higher than 30 per cent. Ore of the Iron Baron is hematite and of low manganiferous content. An estimate of the period likely to elapse before underground mining will be necessary, is given as being beyond this century, based upon the present rate of consumption.

In the past, tug boats sufficed to carry passengers and stores over from Port Pirie; now they transport mainly stores. To-day visitors are offered their choice of service cars from Adelaide, through Port Pirie and Port Augusta, to Whyalla, or of planes direct from Adelaide. Air landing grounds have been formed at Iron Knob and Whyalla.

A visitor who knew the early settlement at Hummock Hill, the hamlet of few dwellings and many tents, and the little inn, will marvel at to-day's model town of Whyalla, with its air of modernity, its industry and compelling sense of efficiency. The contrast will move him to pride in this achievement of Australians.

One may travel by motor car or by rail from Whyalla out to Iron Knob. The tramway is of 3 ft. 6 in. gauge laid with 80 lb. rails. The traveller notes the Monarch, with the shattered scarp of the Knob to the east. The Monarch has been cut to the form of a table mountain by the mining of the years. This has produced the 120 feet face of Bench A., the 160 feet face of Bench B., and the 100 feet face of Bench E.

Early in development, the Monarch was subdivided by survey and sampling into areas each of 100 feet square. The samples taken from outcrop, pothole and costeen, offered guidance for sample



BLASTING SIX TOP AND BENCH HOLES AT IRON KNOB.

maps and contour plans. Benches A., B., and E. were then cut about the Monarch. Each bench floor extended widely and more widely into the hill, with the mining and despatch of ironstone.

By March last, 10,500,000 tons of high-grade ore had been mined and despatched from Iron Knob, chiefly from the Iron Monarch ore body.

To-day, Bench E. is the scene of chief activity. It has an effective working length of 2800 feet. Its wide floor or terrace curves along the Monarch below the red blue and black face of 100 feet of height. The hill is being cut down, layer by layer, and when this great crown is lifted, a maximum height of face of 150 feet will have been worked, and 13,000,000 tons of ore will have been removed. Then the layer between Benches E. and A. will be worked for an estimated yield of 27,000,000 tons. The bench below is estimated to yield 40,000,000 tons, and the next bench 50,000,000 tons.



DRILLING BOULDERS FOR BLASTING, BENCH E.



LARGE-SCALE BLASTING OPERATIONS

Operations on the great platform and at the high face of Bench E. are on a grand scale. In early operations, the drilled rock was blasted from the bench face. Then the boulders were again drilled and blasted, and the ore broken down with spalling hammers for loading into 5-ton quarry trucks. Huge shovels and crushers have been substituted for early methods.

The ore face is drilled first, "bulled" or chambered to admit charges of explosives ranging from 200 to 400 lbs. in each hole. Explosives consist of 75 per cent. blasting gelatine for chambering, and 25 per cent. ligdyn for primary blasting. For secondary blasting, occasionally necessary, 50 per cent. gelignite is used. All holes are electrically fired with current from the mine 70 volt mains. Every known precaution is used to prevent accident.

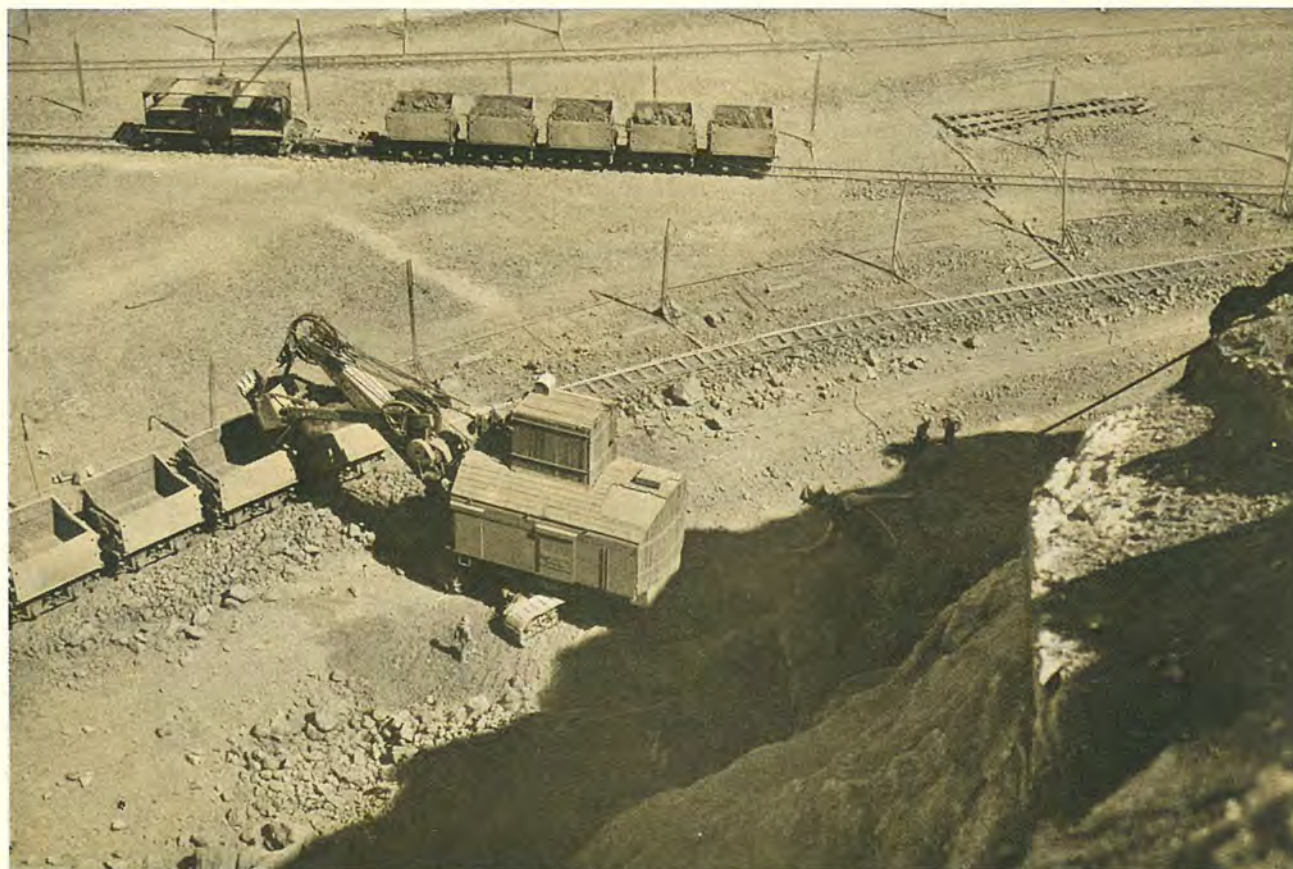
The mine is equipped with electric shovels of four cubic yards dipper capacity, and with a rated power of loading 400 tons per hour into side-tipping waggons of 30 tons capacity. The loaded trucks are railed to the crusher, traction being provided by 600 volt D.C. electric locomotives, with a petrol-electric locomotive as a standby. A dummy truck, to prevent injury to the locomotive from falling stone, and six steel trucks form a "rake."

At the crusher the "rake" is discharged truck by truck, a crane of 50 tons capacity, electrically operated from the 600 volt traction supply, being the operating factor. By the extension of the runway this crane has been made available for erecting or dismantling the crusher, or for fitting locomotives, rolling stock and other mine equipment. Structure, mechanism and runway are of Australian production and the electric equipment of British. In addition to the 50-ton hoist, a smaller one of 20 tons, working more swiftly and used mainly for truck tipping, has been installed.

The crusher is of standard double-toggled jaw type, with a jaw opening of 84 in. by 60 in. The frame is sectional and constructed of cast steel, the whole exceeding 200 tons in weight. Its



ELECTRIC SHOVEL LOADING ORE AT NIGHT.



BENCH E FROM TOP OF MONARCH.

rated capacity is 1000 tons of ore per hour, which is crushed from a maximum size of five feet cube down to 10 inches. Pitman and main shaft bearings are water-cooled, and all bearings are force-lubricated with grease.

The crusher is driven at 90 r.p.m., through 12 cotton ropes, by a 300 h.p. 3000-volt induction motor of special design. Automatic starting and control are provided. The motor has a special slip-resistance, connected permanently in series with the rotor, to allow full advantage of the inertia of the crusher rope-pulley and flywheel.

The motor is self-ventilating, requiring 90 cubic meters of air a minute. This air is drawn through an oil filter, and is finally discharged into the crusher house, where it creates a slight positive pressure and assists to prevent the ingress of dust.

From the crusher the broken ore is discharged into a bin, fronted by a timber and steel strutted retaining wall, cut from the face of the rock below. The storage bin is raised on a concrete foundation from the floor of Bench A. In the excavation for this bin a great central pillar of the original rock face has been left from the top to the bottom. This pillar, which divides the bin into two compartments, each of 2,000 tons capacity, is designed to allow the grading of ore according to its metallic content.

A steel-framed workshop, adjoining the crusher motor house, is equipped for the maintenance and repair work of the operating plant. Power from the Whyalla generating station is brought up to Iron Knob by 34 miles of 33,000 volt A.C. transmission line, the whole of which, poles, cables, insulators, and fittings, are Australian made. Provision has been made to install a second circuit on this rigging.

At the Iron Knob sub-station, at Bench A. level, the line leads to an outdoor switch yard, and the voltage is stepped down to 3,300 volts by current transformers. These transformers are fitted with tertiary windings which (in delta) are capable of supplying current at 510 volts.

At Bench A. level, ore is delivered from the storage bin through steel chutes into little trains of steel hopper waggons, each of which consists of three 10-ton waggons. The wide floor of Bench A. is 420 feet above the level of the Iron Knob tramway. The little trains haul the ore from the great bin to the head of the gravity-operated incline. On reaching the incline tip, the train halts, and the ore is discharged from the hopper-trucks into the incline trucks immediately below for transit to the



great train-loading bin at plain level. The incline is of the self-acting, double-track type with separate main ropes, and a common tensioning tail-rope, to prevent surging and to take up stretch automatically.

Loaded, the trucks sweep down the 300 feet drop between the head of the incline and the top of the train-loading bin, into which the trucks automatically discharge their ore. The maximum running speed is 40 miles an hour, and the incline's capacity is 3000 tons in an eight-hour shift, a striking illustration of celerity in despatch of ore. The incline, one of five for the swift transport from bench to plain level, is equipped with two cylindrical cast steel drums, 11 feet in diameter, each drum carrying 2800 feet of wire rope, five inches in circumference.

The ore is drawn from the train-loading bin by manually operated chutes, 72 in number, into the 50-tons steel trucks, and is then hauled, in trains of from 1400 to 2100 tons net load of ore, down the 33½ miles of graded track, alongside which runs the transmission line to Whyalla. All coal supply is drawn from Newcastle.

CRUSHING AND CONVEYING ORE TO SHIP

On approaching Whyalla, the ore train pulls up at the 100-ton capacity weighbridge. With the load weighed, the trucks are drawn to the bins above the secondary crushers. The bins, receiving the ore from the trucks, hold 400 tons and serve as feed hoppers between the ore train and the battery of five 30 in. by 18 in. steel-framed jaw-breakers.

At the Iron Knob primary crusher, ore is broken down to 10 inches. Re-crushing reduces the size to 4 inches or to 6 inches, according to the class and purpose of the ore. All ore below 3½ inches is passed, by means of a plain bar grizzly before each crusher, directly on to the crusher conveyor belt, which is 36 inches wide, of 8-ply rubber and duck, and runs at 300 feet a minute. The ore, subjected to the crusher, is delivered to the same belt, which carries it to the great storage bin. The great bin has a capacity of 34,000 tons. Through a concrete and steel tunnel with a length of 380 feet, a conveyor belt runs, as the first of the series of eight, extending from the bin



IRON MONARCH BENCHES E AND A FACES FROM SUB-STATION.



IRON PRINCE BENCH AND WORKING FACE.

right out to the jetty-head, 2300 feet away. The stream of ore is loosed from the bins by hand-operated steel chutes over a succession of conveyor belts, the first of which runs horizontally for 350 feet before rising on an incline to the height necessary for delivery on to the second belt. Thence the ore is carried, belt by belt, to the movable cantilever boom, and the conveyor which discharges it into the hold of the vessel.

The mean loading rate at Whyalla is 1000 tons an hour, the jetty conveyors operating at 400 feet a minute. The motor system is started up automatically from a push-button at the seaward end of the jetty. The boom motor starts up first, and when the boom conveyor is up to speed a centrifugal relay allows the starting of No. 7 conveyor motor. When No. 7 conveyor attains its running speed, the contacts of a centrifugal relay, driven by the return side of the belt, close and operate the starting switch of No. 6 motor, and so on successively through the series.

The scrupulous order obtaining everywhere, and the perfection of housing for power plant, workshops, and stores, as well as for the tramway terminal facilities, are indications of a definite policy.

The power house at Whyalla, providing as it does electric current for operations and equipment at the Port, and at Iron Knob, is the nerve centre of the whole system.

The average rainfall over the area is 10 inches a year. The shortage of water formed an acute problem from the early days of the company's occupation and initial development of the leases. The success which attended the manner in which the company's staff attacked the problem of collection and conservation, forms an achievement which is of significance to areas of low rainfall throughout the Commonwealth.

ORDER AND SYSTEM

Evidence of material values derivable from order impresses the visitor to Whyalla. Not only is time saved, but officials and operatives take a manifest pride in their departments.

Shadow-boarding safeguards against delay and expense from lost and missing tools or spare parts. The shadow forms, painted vividly against the wall or rack, enable immediate detection of an article not replaced. The numbered tag is the identification disc of the worker who has removed the object, and is responsible for its return. The workmen recognise the definite value to themselves in the application of the system to the tool chests as to the great workshops.



SUCCESSFUL TREE CULTIVATION

Hand in hand with town-planning went the cultivation of trees, local growth consisting mainly of myall (acacia) trees, mallee, quandong, sandalwood, a species of myoporium (locally known as sandalwood), saltbush, and bluebush. Whyalla and Iron Knob was beset with many difficulties, and for several years only moderate results were obtained. The company persevered, however, the dual aim being to beautify the townships and develop civic pride. Results are to be seen in the streets, in the recreation reserves, and in the school grounds.

In 1932, to give the tree-planting movement a fillip, Mr. Albert Morris, a keen amateur botanist of Broken Hill, who had met with marked success in tree cultivation in that city, was asked to give technical assistance. As a result of his visit a system of tree cultivation from seed has achieved satisfactory results.

Seed is planted in seed trays of half kerosene tins, and as surface watering tends to disturb the seed, the soil is moistened from below by piercing holes in the bottom and placing the trays in water. After germination, each tiny tree is pricked off into a jam tin with a pierced bottom for drainage, then, after attaining six or eight inches, carefully brought a stage further in larger tins, and transplanted. At a height of 12 to 18 inches, the young trees are ready for their permanent positions, and protection is supplied by hessian guards. If the young tree is to be planted in rocky ground, explosives are used to shatter the rock and loosen the ground round about. Trees require artificial watering for some years before acquiring sufficient strength to dispense with this aid. Early trees were mainly Tuart gums, which were found to thrive only where waste water is plentiful, Sugar gums, the drooping Sheoak, Aleppo pines, and Norfolk Island pines.

Since Mr. Morris's visit and the establishment of the nursery, attention has been given to many varieties of Eucalyptus and Acacia, amongst which are included:—

- Eucalyptus Odorata*: Grows to a height of about 20 ft. Has small white flowers. Known as Peppermint Gum.
 - Eucalyptus Stricklandi*: Grows to a height of from 10 to 15 ft. Has large yellow flowers.
 - Eucalyptus Lehmanni*: Small compact tree. Will not withstand frost in its young stages.
 - Eucalyptus Salmonophloia*: Grows to a height up to 40 ft. Has salmon coloured bark. Known as Salmon Gum.
 - Eucalyptus Torquata*: Grows to a height of about 20 ft. Has large red flowers. Other varieties cream and pink flowers.
 - Eucalyptus Largiflorens*: Grows to a height of about 30 ft. Known as Black Box.
 - Eucalyptus Rostrata*: Grows to a great height. Known as Red Gum.
 - Eucalyptus Intertexta*: Sturdy gum, suitable for rocky situations.
 - Eucalyptus Oleosa*: Mallee taken from vicinity of Iron Baron.
 - Eucalyptus Citriodora*: Lemon-scented gum.
 - Eucalyptus Microtheca*: Known as Colabah Tree.
- The Acacias include: Golden Wattle, Mulga, Loderi, Rigens, and Ligolata.



TREES IN SINGLE MEN'S BLOCK, IRON KNOB.



IRON KNOB CONCRETE COTTAGES AND NORFOLK ISLAND PINES.



The last two or three years have seen rapid growth in the Whyalla plantations, and now that a type of tree better suited to the climatic conditions is being cultivated, it is confidently anticipated that the plantations will flourish and make a green spot in the blue-grey of the salt-bush plains.

POPULAR INSTITUTES

Early in the social development of Whyalla and Iron Knob, the company established the institutes, which are the centre of the community life. The high fine building of the Whyalla Institute, with its great hall, library, reading room, billiard room and office, finds much use for concerts, dances, and public meetings. The hall is screened and fitted for sound films.

The old inn has been replaced by an hotel quite up to city standard in service and comfort.

The State school engages the direct and practical interest of the company. Attendance ranges up to over 200 children daily. From these healthy, sturdy youngsters, growing up in conditions of sunlight, fresh air and comfort, apprentices for the works or clerks for administrative offices will be drawn.

Workshops at the school are fitted and shadow-boarded with the facsimiles of parts and tools. The domestic economy class room is equipped and shadow-boarded with perfection of detail and order. The class-rooms are bright and airy; the playgrounds, ample and tree-planted, are provided by the company with swings and shelter shed, and the work of the school is supplemented and developed with classes for the instruction of apprentices, and with classes in shorthand, typewriting, book-keeping, and correspondence. Scholars and students have a creditable record of success in competitive State examinations.

More faithfully than many others, this town of youth typifies modern Australia at work and play. Its living conditions realise the humanitarian aims of great Australian social and industrial movements. It offers all facilities for sport, having an extensive recreation reserve, a nine-hole golf course, asphalt tennis courts, a bathing beach, with dressing and shelter sheds, and a rifle club. There is also a brass band, popular because of its qualities, and the winner of contests.

At an early period in Whyalla's history, troops of Boy Scouts and Girl Guides were formed, the movement being taken up with enthusiasm. An added fillip was given when the then Governor of South Australia, Sir A. Hore-Ruthven, V.C., and Lady Ruthven visited Whyalla and Iron Knob, in 1928. Public meetings were held, and at Whyalla the company set aside, free of rent, a property for the use of the organisations. Since then the movement has progressed solidly, and is now in a highly flourishing state.

Out from the town, and on approach to the channels which converge on the water storage, is a reservoir with a capacity of 30,000,000 gallons. The visitor notes an infinite tracery through the area. Each little mark slants to a central line, suggesting the representation of mountains on a map. He learns that each of these little "scrapers" drains into a central channel, which again links with larger channels. The system spells a challenge to the drought, and, on the result from the latest rainfall, shows a method of water collection significant to the dry areas of the Commonwealth.



PROSPECTING CAMP.



WHYALLA BOY SCOUTS WHO ATTENDED THE MELBOURNE CENTENARY CELEBRATIONS CAMP.



The soil is sandy and the channels constructed by the company fill in with the dry, hot wind, or break with an excess of water in occasional downfalls. Saltbush, bluebush, and scrub, and the litter of leaves and twigs, retain too much of the precious water, hence the adoption of the system described.

With a beneficent rainfall over all the networks and all these runnels, a great body of water, estimated at 17,000,000 gallons, swept down the channels and into the reservoir. The system thus applied successfully to the Whyalla storage has been extended to the leases, where it engages the interest and provokes the imitation of station owners and farmers. Out at those far workings on the Iron Prince, Iron Baron, and Iron Queen group, the clearing of the little water courses down to the channels feeding the storage tank, is the first feature of development noted as the visitor nears this second field of operations. The actual workings at the Iron Prince form a deep gulf; the houses of the group of workers being on the slope above it. The rail terminal for the tramway running down to the main Iron Knob-Whyalla line is linked with the mine tracks.

At Iron Knight and Iron Duke, exploration and prospecting are under way.

INCENTIVES TO SAFE WORKING

Having regard to the character of the industry, the visitor to Whyalla, Iron Monarch, or other "Iron" leases, is at once impressed by the immunity from serious accidents, even when allowance is made for the experience and alertness of the men, and for the safeguards of modern plant. This result is due to the Safety First campaign, which is continuous throughout the company's works. The policy is direct in its appeal to the individual and to the community sense of responsibility.

By a system of groups and records, freedom from accident for a month means that every man within the group receives a bonus. The progress of the period without accident from day to day is recorded on the clock allotted to the group. Safety appeals and warnings of form and phrase are displayed prominently. Regularly the officers and the foremen meet for the discussion of safety devices and precautions. If an accident happens, the causes are studied carefully, and the means, if any, by which recurrence may be prevented, are determined. The policy is carried out with the interest and active co-operation of the men. Through the works, depots offer all first-aid essentials, ready to the trained hands of officers and men.

The company engages a resident medical officer and a trained nurse. The health of the community, as the safety of the workers, is accepted as a solemn trust and responsibility. The whole note of the town of Whyalla is cleanliness—in drainage, in control of streets, and in individual care of housing and yarding.

Control of the milk supply, in itself, affords an object lesson. The company designed and built the model yards, milking sheds, feed bins, and dairy, in a pleasant, open space out from the town. The buildings are white and spotless. Bins on the floor above the milking sheds receive in bulk the fodder which the milker draws off in sufficient quantity for the milking cow. The dairy, cool, and flywired, and of a milk-whiteness, is supplemented with heating of water for washing dishes, buckets, and cans. The three dairymen in Whyalla drive their cows to the sheds for milking. Each has his definite space for his "plant" or equipment; his name is lettered on the wall, and his stock of utensils is shadow-boarded.

Supplies of foodstuffs are shipped or trucked through Port Pirie. The meat supply is drawn from the stations. Policy is to obtain all possible supplies from the district. The market is an asset to the



PANORAMA OF WHYALLA.



WHYALLA JETTY AT NIGHT WITH STEAMER LOADING ORE.

stations and farmers, and is, in itself, an illustration of the mutual benefits of the primary and the secondary industries. A comparative shortage of water and the nature of the saltbush country prevent the development of that rural production which is the logical sequence of the establishment of such works as exist at Whyalla and Iron Knob, with their assembling of an industrial population.

:: Iron Knob ::

While Whyalla, from its situation on the Gulf, has lent itself readily to town-planning, civic amenities and social experiment, the inland remoteness of Iron Knob and its comparative lack of water create a more difficult problem. Water shortage has been countered with vigour and effect. The natural supply is collected in a tank of 1,500,000 gallons capacity.

A notable feature of the deepening and extension of the storage was the discovery of the underground supply, on which the well has been sunk. This supply was formed in a measure by the run from the iron hill, but mainly by the soakage from the earlier storage. The storage is supplemented with the water railed up by the large travelling tanks from Whyalla. In the face of great difficulties, adequate domestic supply is an achievement of administration.

The company's town of Iron Knob is supplemented by the Government town, with its hotel and State school, and its group of homes based on the industry. The social isolation of the earliest days is less. Still, the difficulties of any small centre formed about a remote industry have to be encountered. Absorption in self is morbid for the community as for the individual. The counter-acting policy is the encouragement of sports and recreations by which residents may be brought into contact and competition with residents of Whyalla, Port Augusta, Port Pirie, and the district.

While encouraging sports and recreation, the company has developed its township on the definite policy of the maximum of comfort and interest for its community. Like Whyalla, Iron Knob has its institute, with library, reading room, and billiard room, facilities for dances and concerts, and equipment for sound films.

Live corps of Guides and Scouts, led by capable and enthusiastic committees, are doing all in their power to make the organisations lasting and worthwhile.

The cottages for married men and their families are built to the new standards and with electric lighting and water supply. The single men are lodged in comfortable concrete buildings. Their meals are served in a large mess room, with well appointed kitchen, bakehouse, and offices. Special provision is made for bathing, as Whyalla and the sea are too far off for workaday enjoyment. Provision of bath houses for the men, a feature of the company's industry throughout, has a special value at Iron Knob. The company has provided the general store, which carries all essentials at reasonable prices.

The ore resources above plain-level alone guarantee to the township the life of a century—not the comparatively brief existence of the ordinary mining town outback.



LIMESTONE FROM TASMANIA



MELROSE QUARRY, SHOWING INCLINE TO CRUSHER BIN.

EARLY in the settlement of Tasmania the outcrops of the great deposits of limestone, chiefly of the Silurian age, were used by the colonists. The limestone, collected in blocks, was burnt and slaked, chiefly for mixing with mortar, or for lime-washing walls. The deposits are found from north to south. The curious blue-grey and iron-red outcrop at Melrose on the Don River, eight miles distant from Devonport, had engaged the interest of the district, and exercised the imagination of prospectors, long before The Broken Hill Pty. Co.'s acquisition of the lease of 70 acres on and about the great deposit.

The Company's staff, seeking for the Newcastle Steel Works a reasonably near supply of high-class limestone, in preference to the originally intended Wardang Island supply, inspected Melrose. Tests proved the quality was suitable to the new enterprise. The great limestone bed at Melrose is tilted almost vertically; the surface is deeply pitted and eroded and the overburden is of heavy red clayey soil. A lease was acquired from Mr. James Leary, of Melrose, and from 1916 the quarry has supplied nearly 2,000,000 tons of blue limestone to Newcastle. The average weekly use of limestone by the blast furnaces and the open hearth steel furnaces at Newcastle is 4,900 tons. The capacity of the plant at Melrose is 6,000 tons. Melrose Quarry and its environment are in direct contrast to Iron Knob and the saltbush country. The quarry is situated in a fair and fertile district, and the roads from Devonport pass by uplands green even in midsummer.

The gateway of Melrose is on a green-bordered roadway. The superintendent's house down the road, and the office to the left of the gateway, stand in gardens. The road through the gateway leads past the stables and the ambulance-depot, through a break in the green slope, and the great quarry, deep and wide, opens to the view. Under the sunlight the face of limestone, blue-black, and red-stained, resembles somewhat the face of bench E. on the Iron Monarch. In its youth and strength the labour employed against this face, and on the limestone blasted from the cliff and tumbled on to the quarry floor, is representative of the district. By the retention of this youth and strength the industry has additional value to Tasmania.

From 1916 to 1927 the method of quarrying was to drill the rock with high-speed hammer drills, blast with gelignite, and use manual labour for breaking and filling stone into small side-tip waggons, which gravitated to the crushing plant, and dumped the stone into two 24 in. x 16 in. jaw breakers. The stone, crushed to four inches, was delivered to a 20 in. conveyor-belt for a 600 ton storage bin. Steam was used for compressed air drilling and for the operation of the plant.



TRAIN LOADING AT STORAGE BIN.

In 1927, with supply from the Tasmanian Hydro - Electric department, steam equipment was scrapped and electric motors substituted. The quarry floor was taken down 50 feet deeper. Electric haulage was installed, and the crushing plant reconstructed. A surge bin was placed between the quarry and the crushers, three rotary grizzly feeders provided, and a third jaw-breaker 30 in. x 18 in. added. Electrically operated pumps were put in to cope with drainage and spring water on the quarry floor. The system adopted by the Company of storing and shadow-boarding is applied throughout the Melrose stores and workshop.

The layout of the works is noteworthy. The dumps for overburden and clayey stone are carried well beyond the quarry and served by trucks. On the quarry floor the tip-waggons are horse-drawn to the piles of broken limestone at the foot of the cliff, and are hand-loaded for return to the foot of the incline for automatic electric haulage. Rushed up the steep incline, they are discharged to the crusher bin, which has a capacity of 200 tons. The limestone, fed thence to the crushers, is broken down to four inch gauge, a water spray being used to allay the dust. The broken stone, deposited on a cross belt, is carried on to the long conveyor belt, and borne off to the storage bin, of 600 tons capacity, standing parallel to, and high above, the rail track. Thence the limestone is loaded by chutes into the steel hopper waggons, the locomotive moving slowly forward until each truck is loaded. An average train load is 220 tons.

MECHANICAL HANDLING

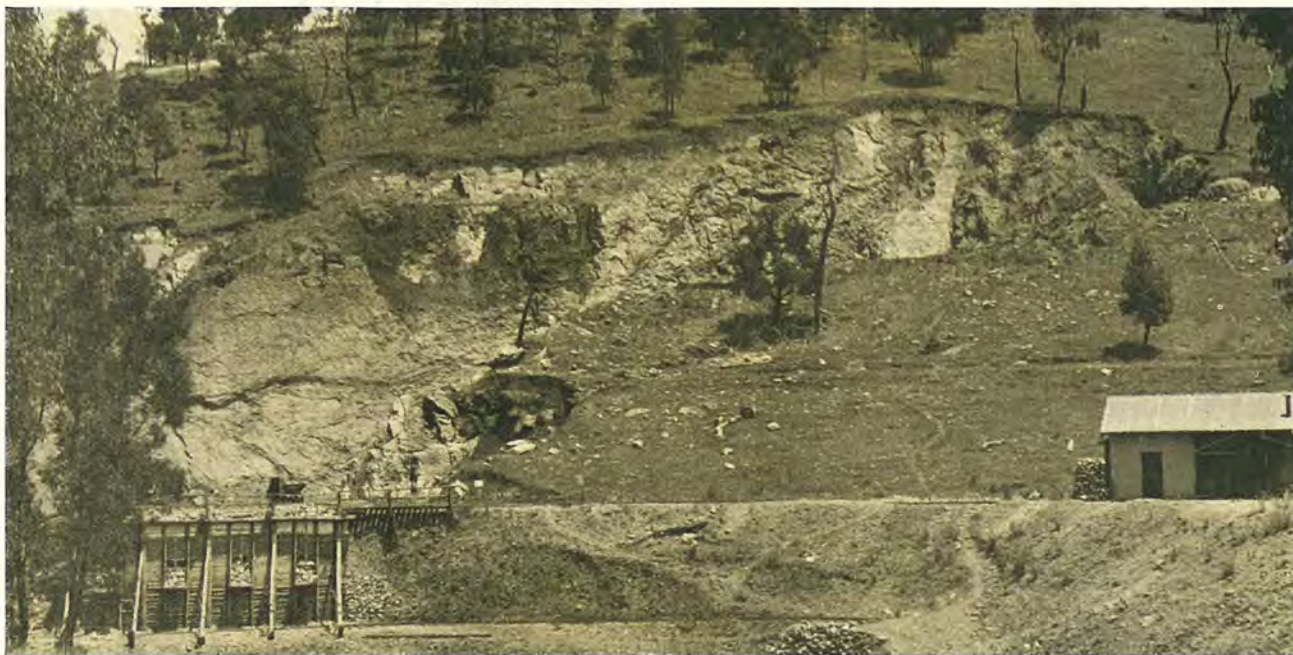
The three feet six inch gauge line to Devonport is constructed over the old Don tramway track. The rolling stock is provided and owned by The Broken Hill Pty. Co., but is operated under contract by the Tasmanian Government railways. Railed into Devonport, the limestone is discharged from the trucks through an underground hopper on to the feed end of a 20 in. conveyor belt. The belt, ascending on a grade of 15 degrees, carries the stone into the 6,000 tons storage bin, steel lined and hoppers, and built high above the wharf, which allows the limestone to pass directly through 30 steel chutes of 35 feet length into the holds of steamers. A maximum loading rate of 2,000 tons an hour is attainable, and an average of 1,000 tons an hour easily maintained. The Mersey Marine Board owns wharf, bins, conveyor, and driving mechanism, but the plant was designed by, and erected under the supervision of, The Broken Hill Pty. Co.'s officers.

The first shipment of limestone from Devonport to Newcastle was made by the S.S. "Odland" in May, 1916, and regular shipments since have added to the activities of the pleasant port.

The quarry, with its efficiency of operation on the strange blue limestone—the spectacle of its haulage, its crushing, and its delivery to bins and to hopper waggons—its environment of beauty on the green slope above the stream, forms a centre of attraction to Tasmanians and mainland tourists visiting the Devonport district.



NEW SOUTH WALES QUARRIES



MT. KNOWLES DOLOMITE QUARRY.

MAGNESITE

THE Broken Hill Pty. Co. operates two quarries for magnesite, which is used as a refractory in the open hearth steel furnaces. One of these quarries is situated at Attunga, in the Tamworth district of northern New South Wales, a distance of nearly 200 miles by rail from Newcastle. The deposit is confined to a crushed zone in serpentine. The magnesite occurs as irregular veins and pockets, and has been formed as a decomposition product from the weathering of the serpentine. The deposit was originally worked as an open cut on the hillside, but now quarrying operations are below surface level, with the additional cost of hauling and pumping. The magnesite is hand-picked from the serpentine gangue, and is transported by motor lorry to Attunga railway station. To date 100,000 tons of magnesite have been produced from the property, which is approaching the point of depletion.

The other quarry, Fifield, is situated in western New South Wales, at a distance of 422 miles from Newcastle by rail. The magnesite occurs in boulder form, as pockets in a greenish coloured decomposed rock. It has probably segregated out during the process of weathering from a highly basic rock. The company has acquired extensive leases, and by development of the property has provided adequate supplies for Newcastle for many years to come.

DOLOMITE

Dolomite also is used as a refractory in the open hearth furnaces. Mount Knowles is the source of the supply. The property, which was acquired in 1920, is in the Mudgee district, 285 miles distant from Newcastle by rail, and is located on Mr. G. D. Hunter White's Havilah Estate. The deposit was first located and identified by a boundary rider. It consists of dolomite beds of the Silurian age, associated with shale and limestone. The outcrop on the hillside rarely projects above the surface level. The quarry here is equipped with power drills, and the dolomite is transported over a narrow gauge tramline to Mount Knowles siding. About 140,000 tons have been consigned to Newcastle, and adequate supplies for the future are assured.

FLUORSPAR

Fluorspar is used as a flux in the open hearth furnaces. Carboona, near Tumbarumba, in New South Wales, is the source of supply, and the Company holds the property under mineral lease. The fluorspar occurs as a vein-filling material in granite country, associated with galena and pyrites. Treatment consists of crushing and concentration. The resulting fluorspar tailings, free of lead, are consigned to the steel works. The lead concentrates are placed on the market. Since acquisition of the property, operations have been only intermittent, chiefly through the limited supplies available in the Commonwealth, and the necessity of conserving this reserve for emergency purposes.



CITY AND PORT OF NEWCASTLE, N.S.W.



SHIPPING

IN early stages of its iron and steel enterprise, the Company utilised the services of existing interstate shipping for transporting ore from Whyalla (S.A.) to the steel works at Newcastle, a distance of 1,170 miles by sea. Later, the same service was used for conveying finished products to consumers.

Difficulties created by wartime shipping restrictions, and the requisition of Australian steamers by the Imperial Government, were to an extent overcome by the charter of vessels. The transport of ore was essential for the maintenance of a vital industry upon which Australia depended for supplies of iron and steel, while the production of munitions had also been undertaken. The post-war world scarcity of tonnage caused the Company to purchase two of the vessels which had been running under charter—the “Bright Wings” and the “Emerald Wings.” Renamed “Iron Prince” and “Iron Baron” respectively, these ships formed the nucleus of the Company’s fleet. The former steamer was wrecked near Cape Howe in April, 1923, while the latter, having become old and out of date, was sold in 1930.

The expansion of the industry brought with it the necessity for expansion in our shipping. Hence three additional steamers were purchased towards the end of 1923, and early in 1925 another was added to the fleet, making five.

The four steamers thus purchased were secured from the Commonwealth Government and renamed “Iron Knob,” “Iron Master,” “Iron Prince” and “Iron Warrior” respectively. They are identical in construction, each being about 6,100 tons dead-weight capacity, built on the “Isherwood” system of heavy longitudinal framing, and are fitted with Babcock & Wilcox water tube boilers and triple expansion reciprocating engines.

TRIBUTE TO AUSTRALIAN SHIP-BUILDING

It is interesting to note that these four steamers were constructed in Australia, and that a considerable quantity of the steel used was manufactured by the Company at its Newcastle works. They have now been running for eleven years, standing up well to the heavy trade in which they are engaged without any sign of strain, thus reflecting great credit on the designers and the workmen responsible for their building. It may be justly said that they compare very favourably with ships built in any part of the world.

Their large hatches, low shelter decks, and efficient cargo-handling gear, including derricks capable of handling up to 30 tons, make them very suitable not only for the carriage of long lengths of structural and merchant steel, but also for handling with ease the bulk cargoes of coal and iron ore. The Company’s fleet provides employment for 156 officers and men, including a wireless operator to each ship.

The bunker coal used by the fleet approximates 112 tons each fleet steaming day. It is supplied from the Company’s own mines, a large proportion being from the Elrington colliery, and the balance from either the John Darling or Burwood collieries.

All ships’ stores, irrespective of whether they are boatswain’s, engineer’s, or steward’s, are all “racked” on shadow boards, in conformity with the Company’s practice throughout all its branches. Afloat, the method has proved a success in every respect, and its most scathing erstwhile critics have become staunch upholders of its utility and effectiveness, while the economy of the system is being continually demonstrated.



S.S. IRON MASTER.



STEEL WORKS WHARF—DISCHARGING ORE.



STEAMERS' EMPLOYMENT

Each alternate week one steamer is loaded at the Steel Works with finished products for Melbourne, and one for Adelaide, the idea being to arrive at the port of discharge on the Monday morning following the sailing day. After the discharge is completed, the steamer sails in ballast to Whyalla, where a full cargo of ironstone, about 5,500 tons, is loaded for the return voyage to Newcastle.

This is the Company's main fortnightly product service. In addition, there is the carrying to Port Pirie and Port Augusta of cargoes of coal from the Company's Elrington colliery, together with any products which are to be delivered at either port. On completion of discharge there, steamers proceed to Whyalla to load full cargoes of ironstone for their return voyage to Newcastle. Large orders for other ports are also delivered by the company's steamers when available. Steamers not required for delivering products are sent in ballast to Whyalla for further ironstone.

LOADING, CARRIAGE AND DELIVERY OF PRODUCTS

At Newcastle, the company's wharf is situated right on the waterfront of the steel works, and has a length of 1,800 feet. It provides five berths, two of which are used for discharging by ore steamers and overseas steamers bringing material to the steel works, and three for loading products.

The whole wharf is fitted with two sets of rails along its entire length, and products from the steel works and all subsidiary companies for shipment to Australian and New Zealand ports arrive at the ship's side on the Company's own railway, drawn by its own locomotives.

The carriage by sea to ports in Australia not served by the Company's own steamers is effected by other Australian-owned vessels, and thus a regular service to all customers is maintained.

The stevedoring by the Company of its own products was but a natural step in its activities. In 1923 a subsidiary company, The Port Waratah Stevedoring Company Limited, was formed for the purpose of loading all products at the Company's wharf and discharging any inward cargo, mainly stores for use at the works. A few years later, in 1929, its operations were extended to Melbourne, where a branch was formed for the purpose of discharging the Company's steamers.

The experience gained from these two minor activities has done much to ensure the delivery of products to the satisfaction of customers. At Melbourne and Adelaide, the harbour authorities have provided suitable permanent berths for the steamers, and, as the cargoes are discharged, each customer's material is sorted and stacked, according to mark, in a position convenient for delivery.

The berth at Melbourne is in the Victoria Dock, where discharge is effected on to a large wharf provided with a roof for the greater part of its length, under which all material liable to damage by weather is stacked. Material for Melbourne which requires discharging direct on to railway trucks is landed at Williamstown.

At Port Adelaide, except under special circumstances, all cargo is discharged up the river at Musgrave Wharf. This berth has railway lines running along its entire length, connected with the South Australian Government network. In addition, there is a large open wharf for the delivery of steel. The Company has erected, under arrangement with the S.A. Harbours Board, commodious sheds for the protection of any cargo liable to damage by weather.

The Company's shipping and delivery service combined has as its object the prompt delivery of material at the point most convenient to customers, and in the best possible condition. With a view to achieving this, the methods of handling and carrying finished products are always under consideration. To assist in loading and discharging, slings, trays, nets and boxes of the most suitable designs for protecting the various classes of material are used.

The loading, carriage, and discharge of ironstone is fully described elsewhere. As soon as loading is completed, and the hatch covered, the steamer commences her voyage down Spencer's Gulf on her way back to Newcastle. The average time for this passage is 5½ days. On arrival at Newcastle, the steamer goes straight to the steel works ore berth, where the ore is unloaded. During discharge, all stores required are placed on board. On completion, the coal bunkers are replenished and the steamer is then ready to load a cargo of finished products or to sail in ballast to Whyalla for another cargo of ore. Ore required in excess of the quantity which the Company's steamers are capable of handling, is shipped by other Australian-owned coastal steamers. All limestone from the Company's quarries at Devonport is also shipped on this basis.

PRODUCTS DESPATCHED:

The products (iron and steel, etc.) despatched from the Steel Works by rail and steamer for the year ended 31st May, 1935, amounted to 519,457 tons.

NEW STEAMERS

The B.H.P. vessels are now from 12 to 14 years old, and in view of the great advances made in the design, equipment, and economical working of cargo steamers, the Company has decided to acquire larger and faster vessels. Preparations are already in hand to build two such vessels of the highest class and specially designed to meet the requirements of all phases of the Company's trade.



VIEW FROM PORTICO OF ADMINISTRATIVE BUILDING.
STEEL WORKS, NEWCASTLE, N.S.W.



IRON AND STEEL WORKS, NEWCASTLE



THE BROKEN HILL PROPRIETARY CO. LTD. ADMINISTRATIVE BUILDING. NEWCASTLE

LIKE a young giant whose promise is even greater than his achievement, the Newcastle Steel Works are symbolical of Australia. Upon most laymen, the aggregation creates an impression of ingeniously controlled and directed forces harnessed to the national service. The sense of mastery of these forces in producing a vital commodity of infinite uses is heightened as the scale and mass of the plant are realised on closer acquaintance.

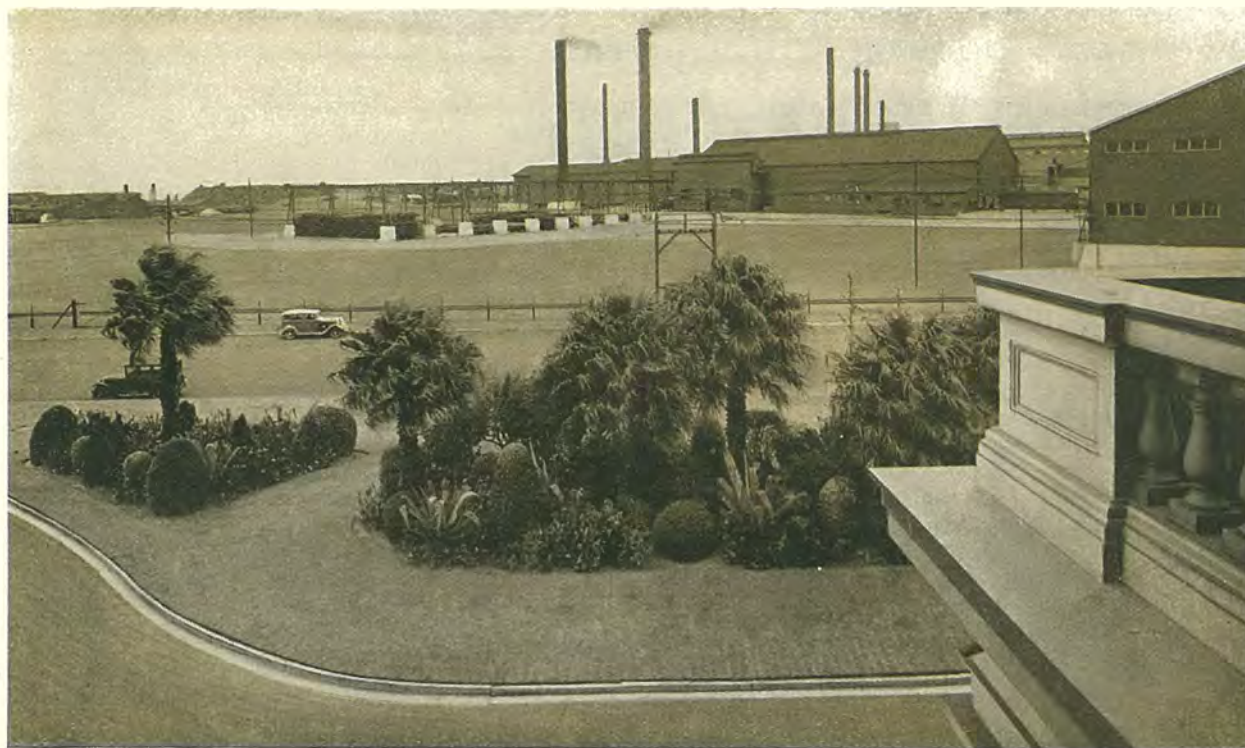
By-product coke ovens, blast furnaces, steel open hearths, mills, power plant, workshops, long busy wharves, ore bridges and ships combine to awe and fascinate the beholder.

It seems almost incredible that all this vast aggregation has arisen from mangrove swamps and tidal mud flats remorselessly conquered by a myriad driven piles, concrete masses reinforced with steel, and fillings of broken slag. The enormous works were planned with vision. Unit by unit, the plant has been so laid out since inception twenty-one years ago, that the whole assemblage operates without the least hitch, from reception of the iron ore, limestone and coal, to despatch of the finished products.

Here in luminous profusion are types and exemplars of the machine age. All the rumbling movements, shifting, conveying, lifting, and transforming, are effected by mechanical agency.

Iron ore discharged by electric-operated grabs from the ship's holds could be converted into pig iron and reloaded into the same vessel in less than sixteen hours, without having touched the ground.

Visitors usually call first at the administrative building, a dignified spacious structure, rising high above lawns and palms. The rooms are cool, airy, and well lit. The order and precision which obtain here are significant of those throughout the industry. Thenceforward, a round of inspection confirms this impression and affords repeated pictures of plant, housing, and operation combined to yield efficient technique and sound practice.



A GLIMPSE OF THE STEEL WORKS FROM THE ADMINISTRATIVE BUILDING.

EMPLOYMENT STATISTICS

The Broken Hill Proprietary Company Limited, Subsidiary and Allied Industries

EMPLOYEES IN INDUSTRY

The Broken Hill Pty. Co. Ltd. and Subsidiaries:

Newcastle Steel Works	4,671
N.S.W. Quarries	57
Collieries (B.H.P.)	1,229
Steamers (B.H.P.)	156
Iron Knob and Whyalla	802
Melrose Quarry (Devonport)	125
Gold Mines	130
Broken Hill Mine	15
Head Office and Branches	163
Rylands Bros. (Aust.) Ltd.	875
B.H.P. By Products Pty. Ltd.	55
Port Waratah Stevedoring Co. Ltd.	280
Australian Wire Rope Works	76
Lysaght Bros. & Co. Ltd.	1,200
Titan Nail & Wire Pty. Ltd.	31
Commonwealth Steel Co. Ltd.	400
Structural Engineering Co. of W.A.	23

Allied Companies:

Lysaght's Newcastle Works Ltd.	1,450
Stewarts and Lloyds (Aust.) Pty. Ltd.	436
Stockton Borehole Colliery	433
Newbold Silica Brick Co.	60

10,288

2,379

In addition to which it is estimated indirect employment is afforded in the supply of materials purchased by the Company 12,132

CAPITAL EXPENDITURE: The amount expended on plant, machinery, etc., in the Iron and Steel Industry, as carried on by The Broken Hill Proprietary Company at Newcastle, Iron Knob, Whyalla, Devonport, and the various quarries, totals approximately TEN MILLION POUNDS.

WEEKLY WAGES BILL

The Broken Hill Pty. Co. Ltd. and Subsidiaries:

Newcastle Steel Works	£23,890
Iron Knob and Whyalla (S.A.), Devonport (Tas.) and the various Quarries	4,040
Collieries	8,429
Steamers	800
Gold Mines	700
Head Office and Branches	1,250
Rylands Bros. (Aust.) Ltd.	3,850
B.H.P. By Products Pty. Ltd.	270
Port Waratah Stevedoring Co. Ltd.	830
Australian Wire Rope Works Ltd.	312
Lysaght Bros. & Co. Ltd.	5,000
Titan Nail & Wire Pty. Ltd.	90
Commonwealth Steel Co. Ltd.	2,500
Structural Engineering Co. W.A.	90

Allied Companies:

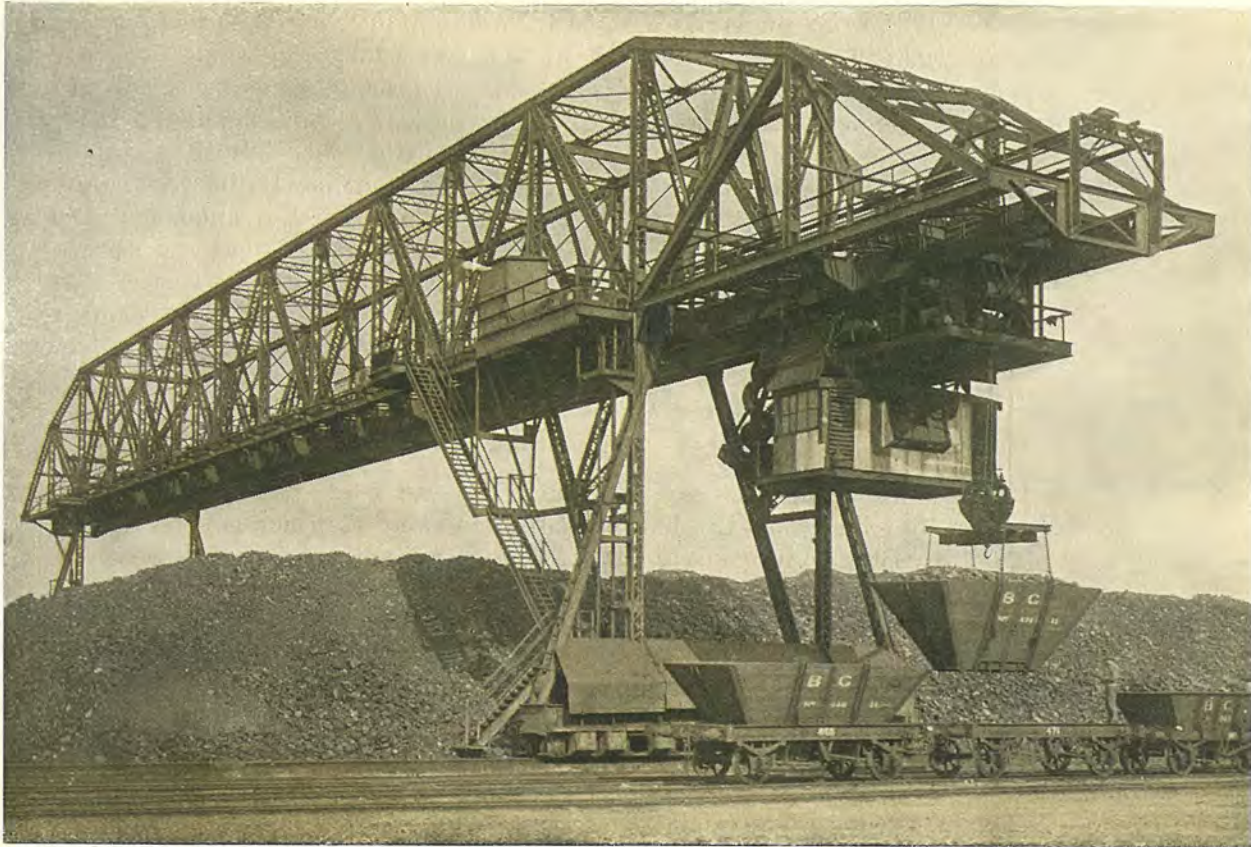
Lysaght's Newcastle Works Ltd.	£7,250
Stewarts and Lloyds (Aust.) Pty. Ltd.	1,812
Stockton Borehole Colliery	2,542
Newbold Silica Brick Co.	240

£52,051

£11,844

TOTAL YEARLY WAGE BILL - £3,322,540

NUMBER OF SHAREHOLDERS: The number of shareholders in The Broken Hill Proprietary Co. Ltd. is approximately 10,000.



THE COAL STACKING BRIDGE—THE LARGEST IN AUSTRALIA.

Weight, 400 tons; Overall Length, 300 ft.; Capacity, 250 tons per hour; Storage Space, 1750 ft. long, providing space for 150,000 tons of coal.

COKE OVENS AND BY-PRODUCTS PLANT

A LIKE in magnitude, ingenuity of construction, and subtlety of process, the coke ovens and by-products plant ranks with the greatest industrial units ever assembled in the Commonwealth. Coke is an important item in the "mixed grill" fed into blast furnaces for pig iron production.

In the early years of the steel works, the coke ovens fascinated visitors by brilliant scenes as the glowing bank of coke was discharged from the oven. To-day the whole plant excites admiration, not only by its scale and extent, and the effects of incandescence, but also by the astounding refinements of control in extraction processes.

Dominated by lofty stacks and high concrete storage bins above the dark line of ovens, the installation also has the beauty of great architecture.

The cost of this section of the Newcastle Works exceeded one million pounds. The contract, placed in August, 1928, for the erection of 106 Wilputte coke ovens, with complete coal-crushing and coke-handling plant, and apparatus for the recovery of tar, ammonia and benzol products, formed the largest order for a by-product-coking installation placed in Great Britain up to that date.

The 106 Wilputte ovens are arranged in two batteries of 53. They are separated by a concrete coal bunker, 143 ft. high, with a capacity of 2,230 tons of coal. The two batteries have a carbonising capacity of 17,000 tons of coal each week, and the production from the plant on this basis is:—

- 11,000 tons of metallurgical coke.
- 1,100 tons of coke breeze.
- 190 million cub. ft. of gas, of which 109 million cub. ft. are available for distribution through the works.
- 190 tons of sulphate of ammonia.
- 40,000 gallons of benzol, toluol and solvent naphtha.
- 120,000 gallons of tar.



COKE OVENS.



COKE OVENS BY NIGHT.

Of the 20,000 tons of coal delivered weekly at Port Waratah, 17,000 tons are required for the coke ovens and by-product plant. The coal trains draw up at the six steel bins which are the portal of the plant. Into the bins the hopper trucks dump their coal at the rate of 350 tons per hour. Reciprocating feeders deliver it on to a series of conveyor belts leading to the Bradford breaker — the first of its type to be installed in Australia.

This breaker attains a circumferential speed of 400 ft. a minute, and at this rate the lump coal is lifted high, dropped with force and rapidly shattered. Reduced to $1\frac{1}{2}$ in. size, the coal passes through screen plates to a conveyor belt, which delivers it into one of the four 250-ton concrete bins at the coal mixing building, 117 feet high.

The production of metallurgical coke, with the requisite physical and chemical characteristics, can be effected only with correct blending of the coals available. The four bins allow the separate storage and subsequent blending of four distinct qualities of coal. Rotary feeders deliver the coal through steel chutes into two large hammer mills, each of which pulverises 200 tons of nut coal an hour.

Thence the fine coal passes on to a conveyor belt, which climbs to the top of the large concrete bunker containing 24 hours' supply for the Wilputte ovens. From this bin the coal is conveyed in 15-ton batches, by means of an electric larry-car, fitted with canisters, which deposits the contents through four charging holes in the top of each coking chamber.

The Wilputte ovens are of the regenerative type. All portions of the structure subjected to high temperatures are formed of silica brick. Each oven chamber is 43 ft. 5 ins. long between doors, by 13 ft. 3 ins. deep and 16 ins. in average width.

GLOWING CARLOADS FROM THE OVEN

Perfection of mechanism heightens interest and picturesqueness. With the 15 tons of coal carbonised the oven coke content is accordingly reduced to $10\frac{1}{2}$ tons. The self-sealing doors on each side of the oven are swung open, and the coke discharged by an 85-ton pusher machine. The high red pillar of coke issues through the steel bratticed guide on the quencher side of the oven, and, collapsing, goes down into the waiting car of stout construction with a sloping floor of cast-iron plates. The 18-ton electric locomotive propels the car with its glowing load under a concrete water tower, and through separate spraying pipes, 5,500 gallons of water quench the coke in one minute. From this violent





shower-bath, the steaming coke is allowed brief time to drain before being discharged on to a brick-lined wharf, finally passing to a belt conveyor, which hurries it off to a screening station.

Here the coke goes over a rotary screen for removal of all smalls or "breeze." The large coke is filled into 40-ton tripper cars for despatch to the blast furnaces. Coke breeze is re-screened over shaker screens for the recovery of nut coke and fines. The nut coke is used in gas producers, whilst the fines are burnt on chain-grate stokers at the boiler plants.

The volume of gas produced daily from the two batteries of Wilputte coke ovens at the steel works is 27,000,000 cubic feet, enough to serve a city of over a million people. From the ovens it passes through elaborate processes for the recovery of tar, ammonia, and benzol products.

The gases are drawn by suction through primary coolers. These tall towers are flushed with a large volume of cold ammonia liquor, resulting in effective cooling of the gas, almost complete condensation of tarry vapours, and partial condensation of ammonia.

RECOVERY OF OILS AND TAR

The tar is pumped into a large storage tank prior to being delivered to the new tar distillation plant for the recovery of light, middle, and heavy oils, naphthalene and various grades of road tar. The ammonia liquor passes through a modern distillation unit for the production of concentrated ammonia liquor.

On leaving the primary cooler, the gases enter one of the turbine-driven exhausters, capable of delivering 23,500 cubic feet of gas a minute. From the exhausters the gas forces its way through a tar extractor for complete removal of tar-fog, and then enters a saturator filled with weak sulphuric acid for the complete removal of ammonia.

Each saturator is capable of scrubbing the whole of the ammonia from 31,000,000 cubic feet of gas per day.

Within the saturator, crystals of ammonium sulphate are constantly deposited from the super-saturated acid solution. These are ejected to a bronze draining table and are periodically diverted into centrifugal driers, where the sulphate of ammonia is thoroughly washed. Final drying follows, and then the dry neutral sulphate is conveyed to a storage hopper for bagging and shipment.

The ammonia-free gas leaves the saturator and enters a large final cooler. Here it is intensively sprayed with water and cooled before the removal of crude benzol is undertaken. The four benzol scrubbers which follow are each 12 ft. diameter and 90 ft. high. The gas flows through these vessels and is scrubbed with a large volume of absorbent oil, the oil absorbing the benzol vapours from the cool gas. This "benzolised" oil is pumped direct to the benzol plant, where it is distilled in order to separate crude benzol, which is chemically washed and subjected to fractional distillation in a modern plant for the production of refined benzol, toluol, and solvent naphtha.

The total flow of gas leaving the final benzol-scrubber is measured by a large rotary displacement meter. Forty per cent. passes into a gasometer, thence to both batteries of ovens to serve as fuel gas. The surplus gas, amounting to 15.6 million cubic feet daily, is delivered to heating furnaces throughout the entire steel works, as well as to subsidiary industries.

NEW BENZOL PLANT

This new plant is of the most modern type, with units of large capacity. The main features consist of one oil-stripping still having a capacity of 20,000 galls. of benzolised oil per hour, two rectification stills each of 18,300 galls. capacity fitted with columns 20 ft. high, 6 ft. 6 in. in diameter, together with the necessary vapour-to-oil heat exchangers, condensers, caustic soda vapour neutralisers, product decanters, etc.

The chemical washing of crude benzol is carried out in a vessel 20 ft. high, having a capacity of 9,000 gallons.

Pumps of ample capacity have been installed for handling the various oils and spirits. Control instruments are of the latest type. A modern tank storage compound with a total capacity of 470,000 gallons is also provided.



TAR DISTILLATION PLANT

CONSTRUCTED in October 1934, the new distillation plant at Newcastle is based on the latest German and American practice, and operates on the continuous flow system.

The main unit consists of a large horizontal steel welded still, having a capacity of 8200 gallons of tar, set in a substantial firebrick structure, braced with steel beams. The still can be fired by liquid or solid fuel, the heat passing through two 36 inch corrugated steel tubes which traverse the full length of the unit.

Distillation is effected by continuous operation, or, if necessary, by "batch" process, and the unit can refine 2000 gallons of road tar per hour.

A special feature of the new plant is the ingenious automatic control of the flow of crude tar to the still, and the exacting control of temperature of the boiling tar during the process of distillation.

Modern heat exchangers and condensers permit careful segregation of the various grades of oil evolved during distillation, whilst adequate mixing and storage tanks have been provided.

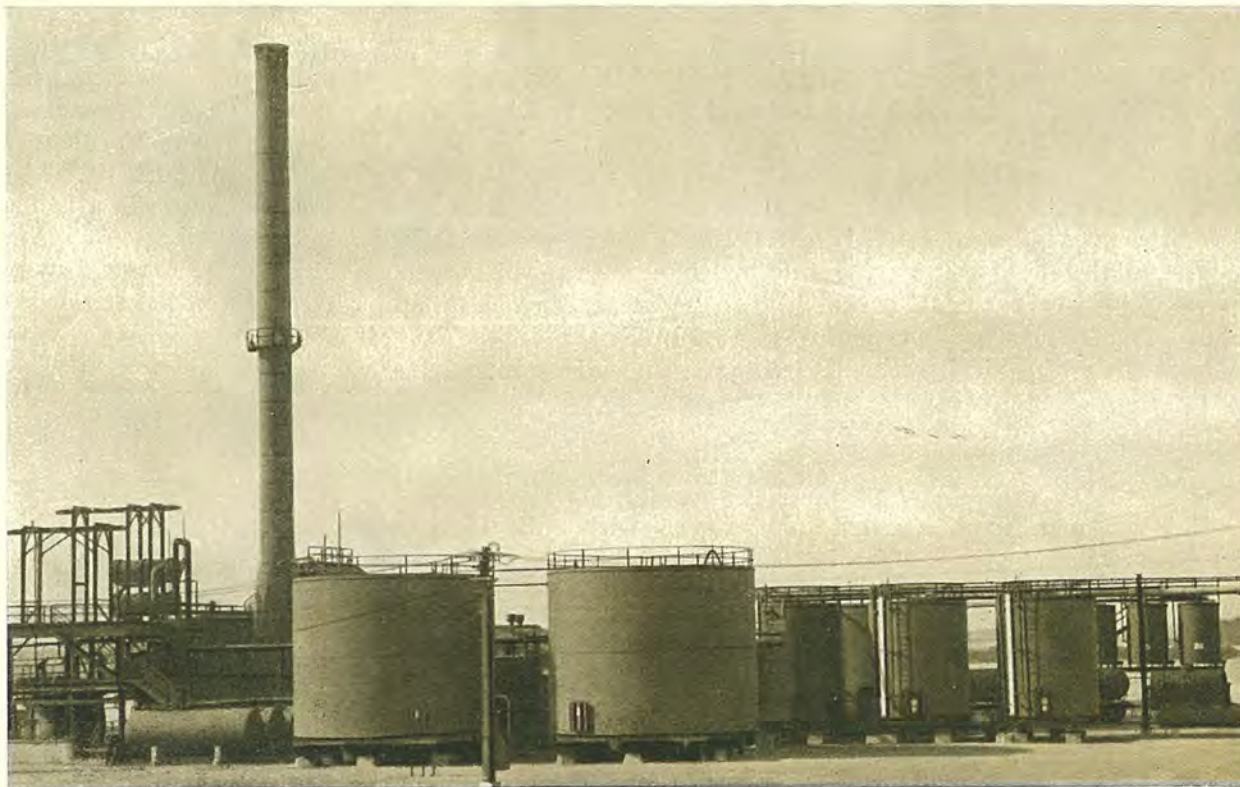
Crude tar, after a preliminary dehydration, is continuously pumped to the still at a comparatively high temperature, so that any water present is immediately vaporised or "flashed off."

"Light" and "middle" oil vapors pass on to their respective condensers. The former oil is subsequently rectified into refined solvent naphtha, whilst the middle and heavy oils are pumped to settling trays, where, after cooling, their supernatant oils are removed from crude naphthalene. This is subsequently centrifuged and then sublimed to produce the beautiful snow-white flakes of naphthalene.

Oil from the draining trays constitutes the crude oil from which tar acids, such as carbolic and cresylic, are produced. It is also greatly used as a wood preservative (creosote), as an atomised fuel, benzol absorbent oil, thinner for road tar, blow-fly oil, and sheep dip.

As distillation of the tar proceeds, refined tar continuously flows from the still to a special receiving tank, whence it is pumped to numerous storage tanks. Samples are regularly tested at an adjoining chemical laboratory to enable the desired quality of road tar to be maintained.

With the ever-growing demand for first-class roads, this thoroughly modern plant is playing an important part in the manufacture of high-grade road tar derived from Australian coal.



THE TAR DISTILLERY.



THE MANUFACTURE OF IRON

Blast Furnace Plant

ALTHOUGH serving only initial phases of steel making, the Blast Furnace Plant, with great conveyor bridges high above the stacks of iron ore and limestone, makes an early impression of spectacular effects. Steel cannot be made without iron, and here are assembled the basic ingredients for conversion into metal by terrific heat.

The 1,800 ft. long wharf accommodates coastal, interstate, and overseas vessels. The mechanical discharge of ore from a Company steamer arrests attention, or the onlooker's fancy may be captured by the smooth, expeditious loading of rails, beams, and other finished products. Ordered sequence of productive forces is strongly suggested by the huge piles of iron ore from Whyalla and of limestone from Tasmania.

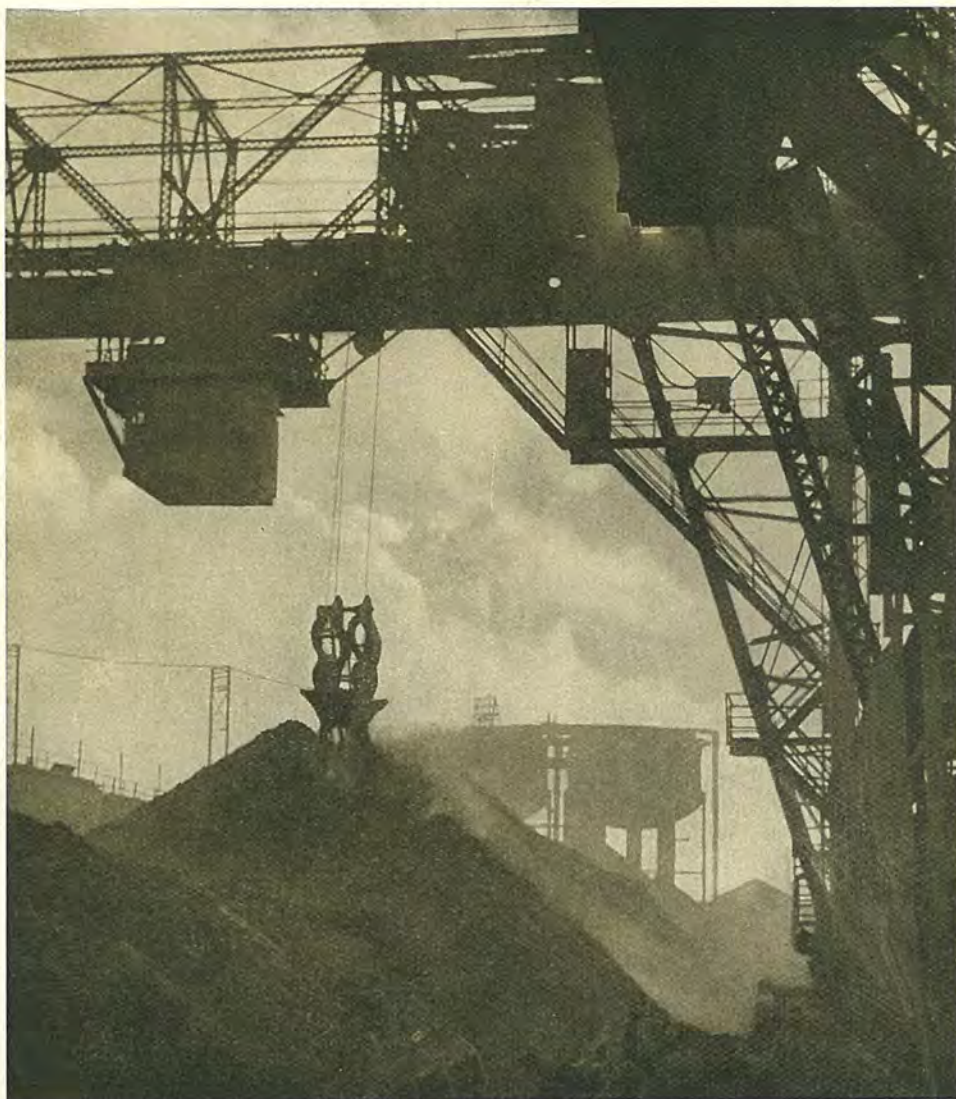
The three blast furnaces, back from the wharf, each with its row of four hot-blast stoves, tower over 100 feet into the air. From the bins at their bases automatic tipping skips convey to the furnace tops their feed of coke, iron ore and limestone. When all three blast furnaces are in full operation, they consume in a year:—

Ironstone—From South Australia	1,035,000 tons
Coke—From Newcastle	622,700 „
Limestone—From Devonport, Tas., and Attunga, N.S.W.	260,000 „
Phosphate Rock—From Nauru and Ocean (Pacific) Islands, and S.A.	1,600 „

Of these three furnaces, No. 1 has produced 4240 tons of basic iron in one week; No. 2, 3925 tons; and No. 3, 5915 tons. No. 3 blast furnace consumes in a day approximately 1250 tons of iron ore, 700 tons of coke, and 290 tons of limestone, using nearly 2500 tons of air for the combustion of coke and the reduction of the iron oxides.

What is a blast furnace, and how does it work? In modern form it consists of a tapered cylindrical steel shell, thickly lined with fire-brick, for the reception and reduction of a variegated "meal" of ore, limestone, and coke. Into this chimney-like structure a continuous blast of superheated air, delivered at the rate of about 50,000 cubic feet per minute, is forced by large blowing engines through tuyeres, or air nozzles.

The Newcastle furnaces are served with two horizontal and three vertical blowing engines and a turbo blower, the largest of which can develop up to 4000 horse-power, and can blow 50,000 cubic



ORE BRIDGE.





feet of air per minute, at a pressure of 25 lbs. to the square inch. A modern iron blast furnace is the largest industrial smelting unit made, and its reactions are probably the most complex of any metallurgical apparatus. Its functions may be stated briefly—to produce the largest tonnage of first grade pig iron economically.

The reactions between the air, coke, ore, and limestone passing through the furnace generate about 130,000 cubic feet of gas per ton of iron produced, and this large gas volume passes from the top of the furnace through suitable dust catchers and gas washers prior to utilisation. About 30 per cent. is required for heating the hot-blast stoves, the balance being consumed at the adjoining boiler plant.

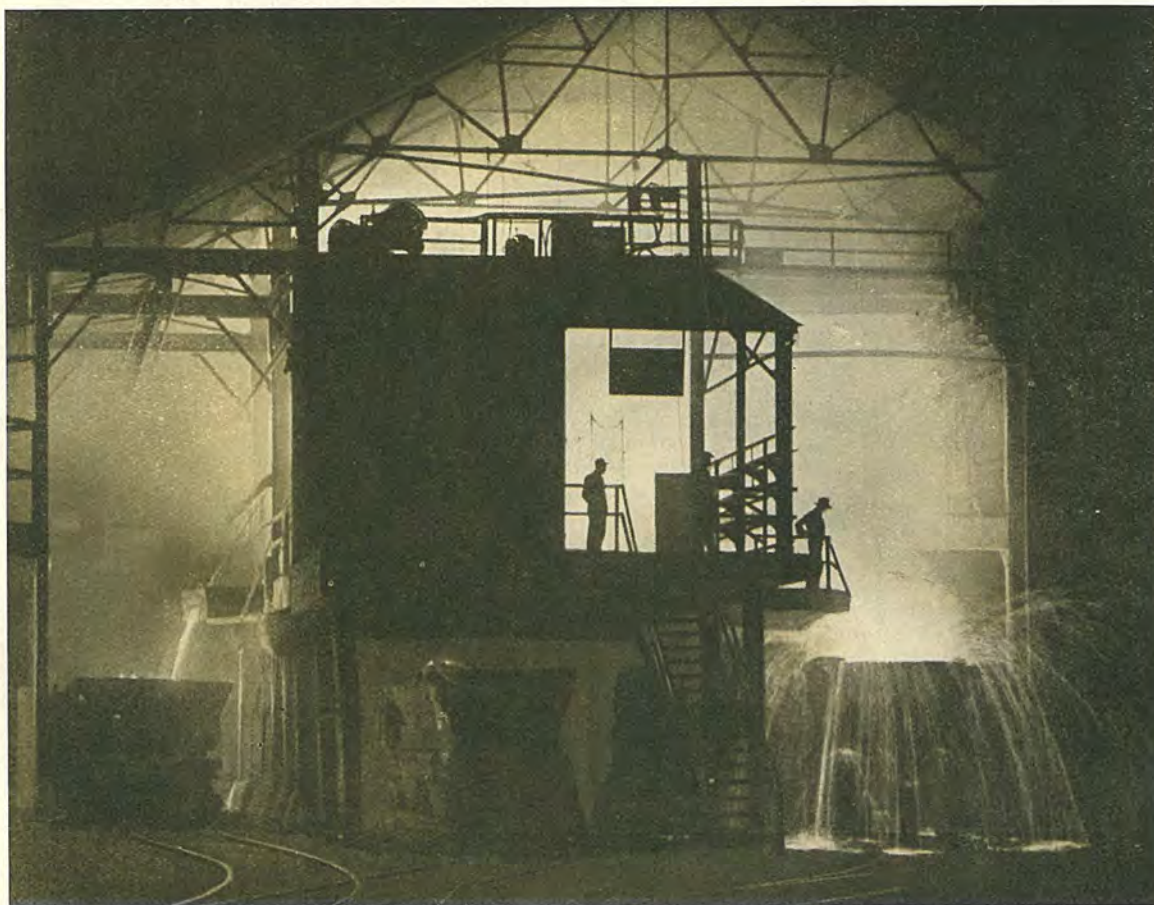
As the charge—or “burden”—descends through the furnace, the ore (oxide of iron) is reduced by being acted on by gases formed in the bosh, and subsequently by the coke itself. The fluxes and earthy matter unite one with another, and later with the coke ash, rendering this extraneous matter into a fusible cinder or slag, regularly withdrawn from the furnace.

The furnace consists of three essential parts:—

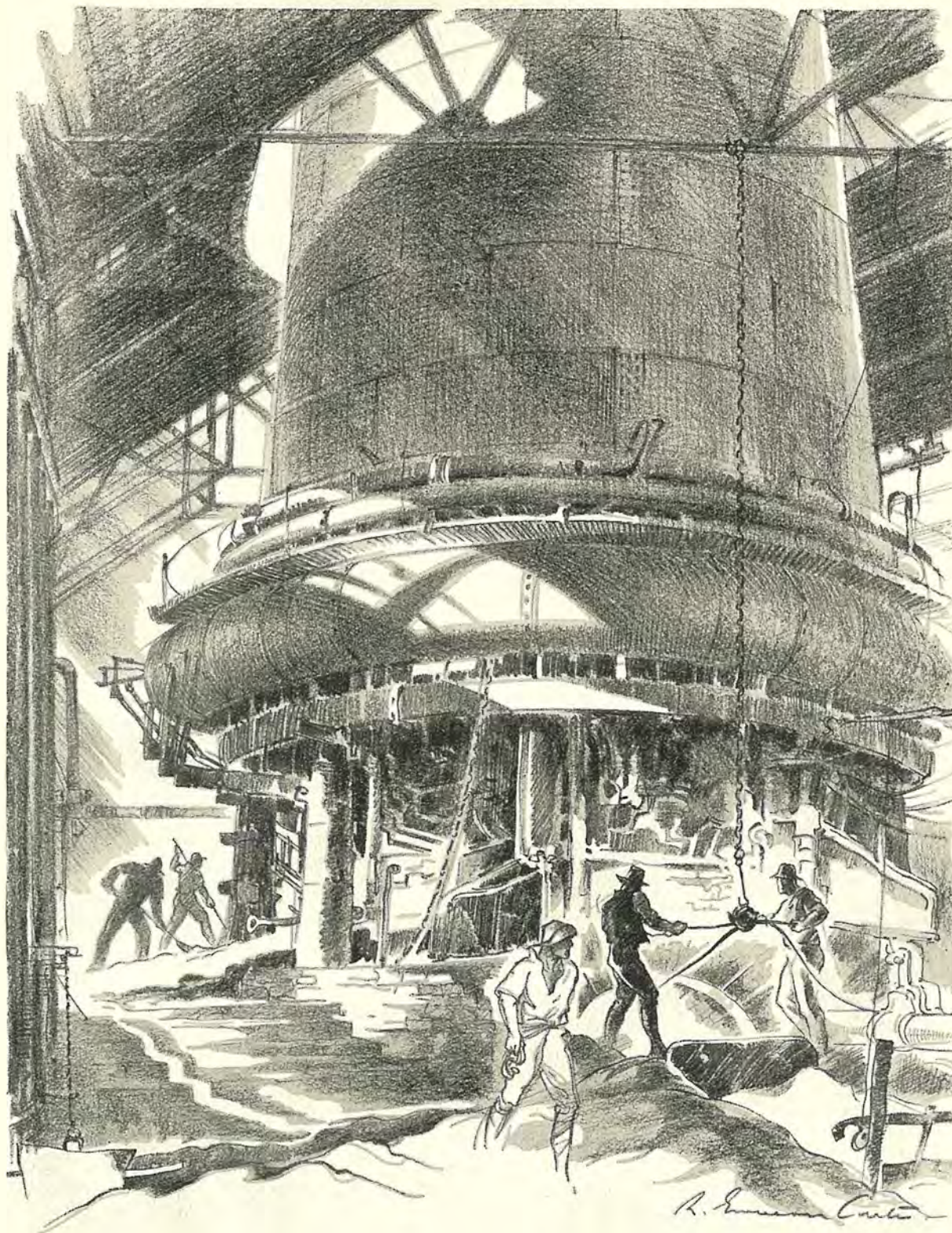
1. The hearth.
2. The bosh.
3. The shaft.

The straight cylindrical portion forming the hearth serves as a receptacle for the iron and slag formed in the upper regions of the furnace. At the top of the hearth are the tuyere openings for passing the blast—or heated air—into the furnaces. Below the tuyeres is the cinder notch for the removal of slag, and below this again the tap hole for the removal of iron. The whole construction is extremely rugged to enable it to withstand the pressure of the deep charge and of the molten iron within the hearth.

The bosh extends from the top of the hearth to the mantle, and is generally about 18 to 24 feet in diameter at the bottom and 20 feet at the top. It is in the form of an inverted truncated cone, the top of which is the point of maximum diameter of the furnace. It is very necessary to protect the bosh and its internal brickwork by a stream of water or by a series of bronze cooling plates set into the lining at regular intervals. The bosh is the point of greatest heat in the furnace, the hottest section being about 2 feet above the tuyeres.



TAPPING BLAST FURNACE.



BLAST FURNACE FLOOR—OPENING THE TAPHOLE.

The charge of ore, limestone, and coke from the skip falls on the small bell topping the furnace, where distribution takes place, thence to the large bell and into the shaft. The two bells are adjusted not to open simultaneously, thus preventing an escape of gas to the atmosphere so that it passes into downcomers, and on to primary and secondary dust catchers and wet washers prior to utilisation.

Sliding down the shaft the charge encounters the hot gases ascending, and, as it slowly descends through zones of increasing heat, the "indirect" reduction of the ore begins, the iron oxide reacting with the carbon monoxide in the gas. This continues until a level of 50 to 55 feet from the furnace top is reached, when some "direct" reduction by the coke takes place. At this stage calcination of the limestone commences, so that it assumes a suitable condition to react with the impurities in the ore and coke to form a fusible slag.

By the time the fusion zone is reached (about the top of the bosh), all constituents of the charge, except coke, are molten. The quantity of coke burning every minute in the bosh of each of the furnaces at Newcastle is about 900 lbs., making about 62,000 cubic feet of gas at a pressure of 15 lbs. to the square inch, and at a temperature of 2800 deg. Fahr. This gas is rapidly expanded and rises with such velocity that in the two seconds of its sweeping through the 90-foot furnace it has reacted with the charge of ore, coke, and limestone.

The air passing into the furnace through the tuyeres has been preheated to approximately 1250 deg. Fahr. Its function is to burn the coke, and furnish heat and gas so that the reduction of the ore to molten iron can take place. Each furnace has four hot-blast stoves, each about 100 feet in height and 22 feet in diameter. Three stoves at a time are heated by the burning gas, while the blast of air is blown through the other, through which it passes to the furnace tuyeres. About eighteen and a half million cubic feet of gas are so used on the stoves of each furnace every 24 hours. Actually the amount of air utilised in iron smelting represents 60 per cent. of the total weight entering the furnace.

BRILLIANT EFFECTS OF TAPPING

Through the incandescent coke the iron and slag dripping down continuously form a molten pool in the hearth; the coke ash passes into slag, and the silicon, some of which is reduced from the silica of the coke ash, combines with the iron. The maximum quantity of iron collecting in the hearth before tapping reaches a height of 3 feet 6 inches to 5 feet. The slag floating on top of the metal is flushed about one hour before the tapping of the iron, and when this operation is completed the workmen prepare to tap about 100 tons of molten iron from the hearth. The tap hole consists of a brick hole of 12 to 18 inches diameter, filled with fireclay, which is drilled through by an air drill. Then the red hot skull formed behind the clay is pierced with a sharp bar, and immediately the molten iron flows rapidly from the furnace. Operatives direct the flow of the slag to its proper channel, and the iron is diverted into several 35-ton ladles standing on a rail track nearby.

The tapping of the blast furnaces by night offers one of the grand spectacles of the Newcastle Works. The base of the furnaces, the cast house, and operatives, are illumined in the strong yellow light, whilst the slag and iron fall in golden cascades to pots and ladles.

Finally, the flow of metal ceases; the furnace is empty and from 100-150 tons of iron is standing in ladles ready to be conveyed to the open hearth plant. The blast of air is taken off the furnace for a couple of minutes to enable the workmen to block up the tap hole by means of clay forced in by a steam gun.

Locomotives withdraw the slag pots, and some half mile away they are tilted to discharge the molten slag down the huge slag dump.

The ladles of iron are shunted to the Open Hearth Steel Melting Department, where two mammoth mixers are ready to receive their molten contents. Only "basic" iron is taken to the open hearth, so that, if the blast furnace is producing "foundry" grades, all metal passes on to the pig mill.

The two pig casting machines comprise two endless belts, the slow travel of which brings the moulds under the pouring spouts, where they are filled with molten iron. During the upwards traverse of the belt the filled moulds are water-sprayed to accelerate solidification of the iron, which is ultimately discharged as "pigs" into trucks below.

RAILWAYS (At the Steel Works)

There are now 44.54 miles of standard gauge railway and 2.76 miles of narrow gauge track in use at the Steel Works.

WATER CONSUMPTION (At the Steel Works)

Fresh Water		13,500,000 gallons per week
Salt Water		350,000,000 gallons per week



STEEL MAKING—The Open Hearth Plant

OPEN hearth treatment presents Act 2 of the drama of heat and chemical reaction converting pig iron into refined steel. These major operations are grandiose, affording many spectacular vignettes of modern industry. Upon the exactitude and firmness of control of all factors depends the quality of the finished steel.

The whole scene about the furnaces at night is suffused in the strong glow of molten metal. At stages, the effects suggest volcanic eruption, and the tapping of white-hot liquid steel, amid the exuberance of dancing sparks, presents a picture of extraordinary brilliance.

The open hearth furnace is so called because its hearth is exposed to the flame, and materials charged into it are in contact with the burning gases. In order to produce the fierce flame necessary for melting and refining steel, the gases must be intensely pre-heated by what is known as the regenerative principle before entering the furnace.

Iron ore contains about 64 per cent. of iron, the rest is mainly oxygen with a small percentage of siliceous matter and other impurities. To produce pig iron the oxygen must be removed by reduction whilst the coke ash and earthy matter in the ore are fluxed away by limestone.

From the blast furnaces, cast iron, or as it is called from old English usage, pig iron, emerges as the crude metal for the open hearth furnaces. It contains about 94 per cent. of iron. In processing this into refined steel it is necessary again to remove impurities and to concentrate the percentage of iron from 94 to about 99 per cent.

The method used in the blast furnaces is now actually reversed, in that the impurities in the pig iron are removed mainly by oxidation; in other words, oxygen is added to the mixture in the furnace in order to oxidise carbon, silicon, manganese, and phosphorus.

Molten basic iron is railed to the open hearth steel making plant, housed in a building 900 ft. long by 125 ft. wide, with the furnaces built in line up the centre.

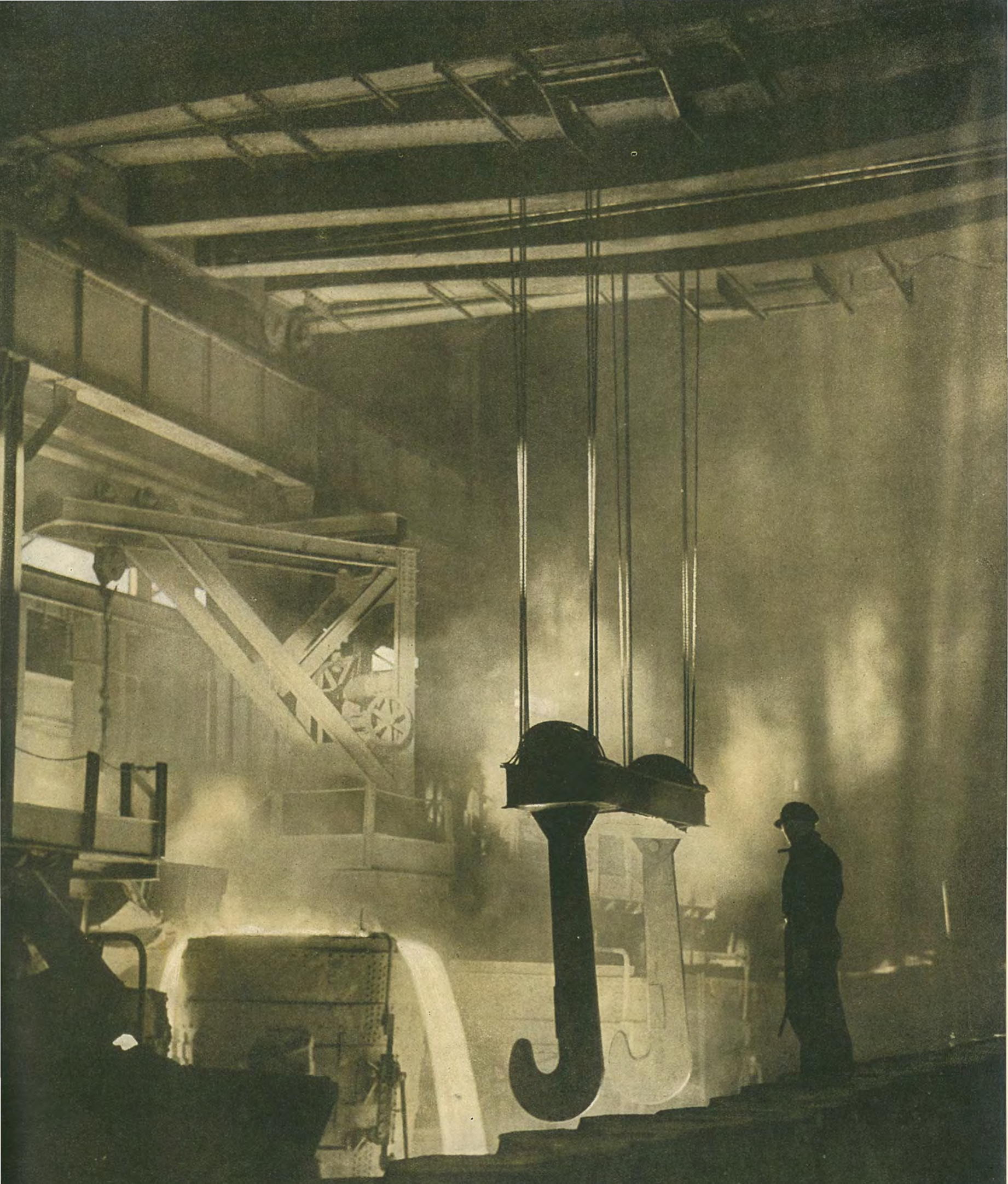
The arrangement forms a division between the open hearth floor, where the furnaces are charged and worked, and the casting pit where the heats are "teemed" into ingots.

This plant is capable of producing 12,000 tons of steel ingots per week, and comprises ten open hearth furnaces, basic lined, four of 130 tons, three of 100 tons, and the remaining three of 80 tons capacity.

The floor, 15 feet above the ground level, is equipped with two overhead cranes of 75 and 60 tons capacity, respectively, and their runways extend along the building from end to end. There are two



OPEN HEARTH—CHARGING WITH HOT METAL.



OPEN HEARTH: TAPPING 100 TONS OF MOLTEN STEEL.



electrically driven charging machines, and two 350-ton inactive type mixers. Blast furnace metal is poured into these on arrival at the open hearth and used as required, the molten iron being kept hot by burners using coke-oven gas.

The furnaces are fired by gas from 34 coal gas producers, although provision has been made for firing with rich coke-oven gas and tar, or any combination of the three.

The "pit," which is on the taphole side of the furnaces, is served by three 100-ton cranes used for handling 80-ton ladles of molten steel.

Each furnace is reinforced by steel joists on all sides, and these, in turn, are braced over the roof by tie rods and beams.

Many courses of magnesite bricks are laid on the base plate, and so built up as to form a shallow hearth not unlike a pie-dish in contour. The back and front walls are also built up of magnesite brick to approximately one foot above the door sills, where they are replaced by silica brick.

The roof and also the gas and air downtakes are of silica brick construction, whilst the gas and air checker chambers are honeycombed with a good quality firebrick.

The front wall of the furnace has five door openings, three large for charging and working the furnace, and two small ones for repairing and inspection purposes. These openings are provided with steel water-cooled doors, raised and lowered as desired. The "charge" comprises limestone, iron ore, scrap steel, and molten pig iron, and in this order they enter the furnace.

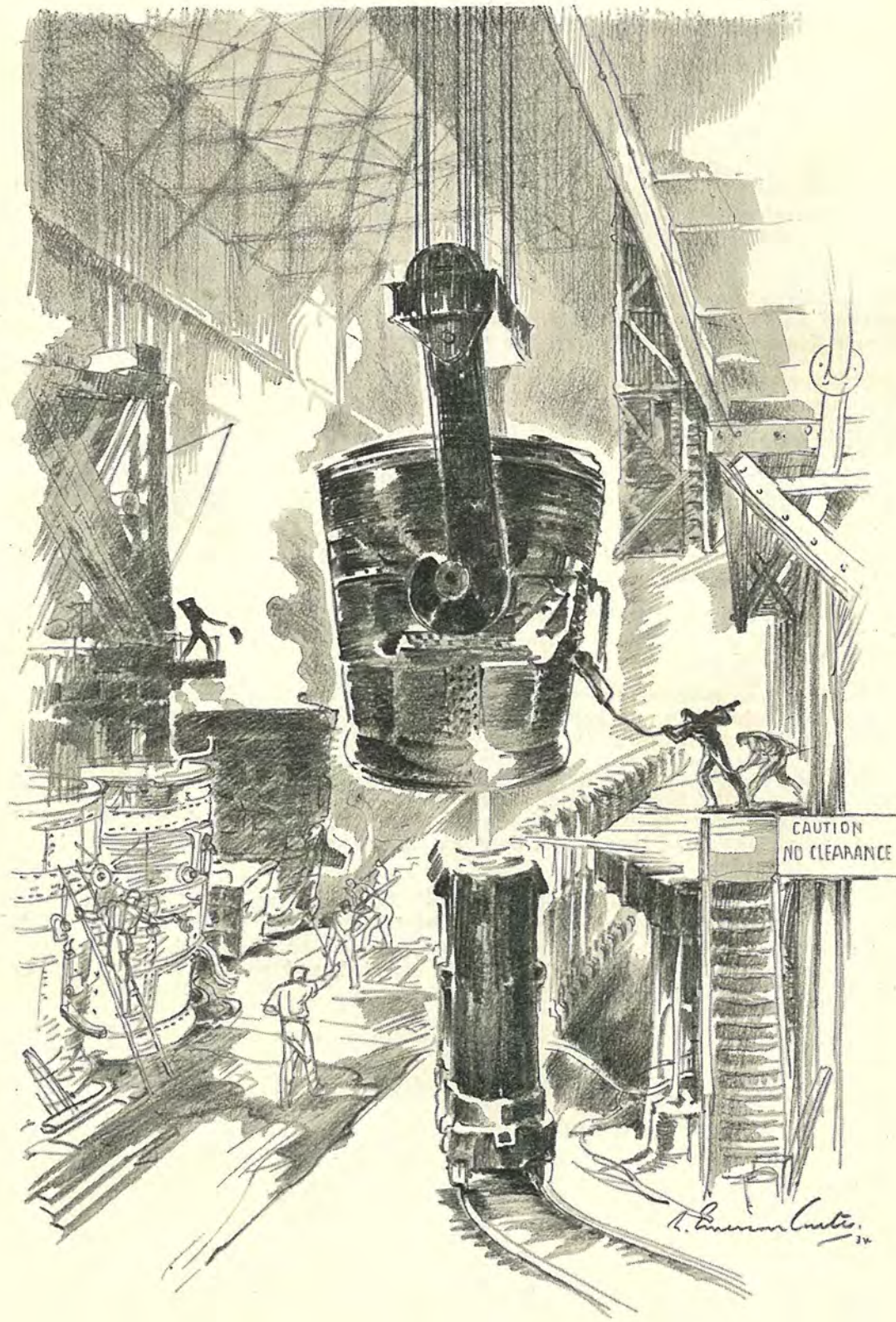
Limestone, ore, and scrap are loaded into charging pans and shunted to rail tracks immediately in front of the furnaces. The charging machine lifts the pans singly and discharges their contents into the hearth.

At the commencement of charging, the flame is turned full on, and the cycle of melting commences. At intervals of 15 minutes the passage of gas and air is reversed by suitable valve mechanism so that the gas and air checkers are alternately cooling and heating. This system of heat regeneration enables flame temperatures of 1800 deg. C. to be maintained.

After a couple of hours, the charge has practically melted and is partially under a cover of highly oxidising ferruginous slag. At this stage one of the charging doors is raised and a brick-lined



OPEN HEARTH—SAMPLING.



OPEN HEARTH—TAPPING AND TEEMING.

launder placed in position with its lip well over the door sill. The 350-ton mixer is tilted and molten iron poured into the waiting ladle. After weighing, the crane hoists the ladle and passes up the floor to where the launder is in position. An auxiliary hoist on the crane tilts the ladle on its trunnions and the hot metal flows via the chute into the furnace.

A violent "boil" results from the reaction between the highly oxidised slag and molten iron, and masses of slag are violently flung upwards. This is due to the liberation of a large volume of gas, mainly carbon monoxide, produced by the spontaneous interaction between the carbon in the pig iron and the oxide in the slag. After about half-an-hour this reaction subsides.

A less vigorous "boil" is then produced by the lumps of limestone which are now freely giving off their gases and rise to float about the bath until absorbed by the slag. Carbon dioxide is in itself violently oxidising to molten steel, and its liberation produces further reactions. The assimilation of lime by the slag increases its basicity, so that phosphorus oxidised in the bath is taken up and held by the slag.

At the subsidence of the second or "lime boil," the bath is broken by a series of ripples and smaller spurts of flame. Much of the siliceous slag has flowed out of the furnace at the first boil, and the intense flame exerts its effect on the thin slag covering the bath of partially refined steel.

SPECTACULAR FLOW OF MOLTEN STEEL

Reactions continue, flame to slag, slag to metal, metal to slag, and so on, continually reversing as the bath changes in composition, until, ultimately, it is comparatively quiescent. Equilibrium has now been reached and reactions practically cease. Provided the chemical analysis is suitable, the slag satisfactory, and temperature sufficiently high, the heat of steel is ready to tap.

Tapping is done on the pit side of the furnace, and achieved by first pricking out the fireclay plug holding the calcined magnesite in position, and piercing the taphole with a long bar from the charging side, liberating the molten steel.

The metal flows down a brick-lined spout into the 80-ton ladle. This is indeed a wonderful sight of high dancing sparks and merciless white heat of such intensity as to make it uncomfortable to gaze upon with the naked eye.

In eight to eleven minutes the furnace is empty, and the slag following the metal sometimes pours over the lip of the ladle and spills on the pit floor, where it advances, hissing and frothing, until cooling and solidification checks its movement.

By this time the bottom and taphole of the furnace have been blown free of tapped metal and slag by compressed air, and the taphole is made up again. The furnacemen then commence repairing the banks with new refractory to make good the ravages of the hearth which have occurred by erosion and heat. At the conclusion of these operations, entailing about thirty minutes, charging starts, and the cycle begins once again.

In the pit, one of the 100-ton cranes lifts the ladle of steel into position over the train of ingot moulds, the stopper is raised, and steel flows in a jet from a nozzle of the ladle, $1\frac{1}{4}$ to $1\frac{3}{4}$ inches in diameter. As each mould fills, the stopper is levered over the nozzle and the crane moves the ladle forward to the next mould. In this way the ladle is emptied, and on the track are 20 to 40 ingot moulds with fast solidifying ingots of refined steel.

MATERIALS USED AT THE OPEN HEARTH PLANT

	Tons per week		Tons per week
Pig Iron	8,080	Fluorspar	26
Scrap Steel	2,498	Dolomite	285
Iron Ore	1,216	Ferro Silicon	73
Limestone	681	Ferro Manganese	
Magnesite	182	Ferro Phosphorus	
Chrome Ore	64	Aluminium	

Totalling 13,105 Tons per Week.

STEEL ROLLING—The Bloom Mill

IN weight and mass of metal handled and shaped, and in scale and variety of heavy work, the bloom and rail mills are regarded as the core of the steel rolling plant. Order, method, and precision are dominant impressions.

The squat cast steel ingot, weighing $3\frac{1}{2}$ tons, after about 17 passes through the huge rollers forming the blooming mill, emerges as a lengthy bloom approximately $8\frac{1}{2}$ in. square. This product from the blooming mill is the feed for the 28 in. rail mill or the 18 in. continuous mill. The three mills are located in a building 675 feet long by 70 feet span, served by two 60-ton and one 15-ton overhead electric cranes. Trains of full ingot moulds pass over weighbridges before being delivered into the soaking pit building. There are seven soaking pits, each capable of holding 24 ingots. The ingot moulds are stripped off the ingots by two 150-ton stripper cranes, and the ingots are then placed in the pits by two 5-ton soaking pit cranes. The soaking pits, of the vertical regenerative type, are fired by either coke-oven or producer gas, or a mixture of both.

Here the ingots are thoroughly "soaked" by heat to the desired rolling temperature. Then, withdrawn from the pits by a crane and placed on a roller table, they are conveyed to the 35 inch bloom mill, and rolled into blooms or slabs of various sizes.

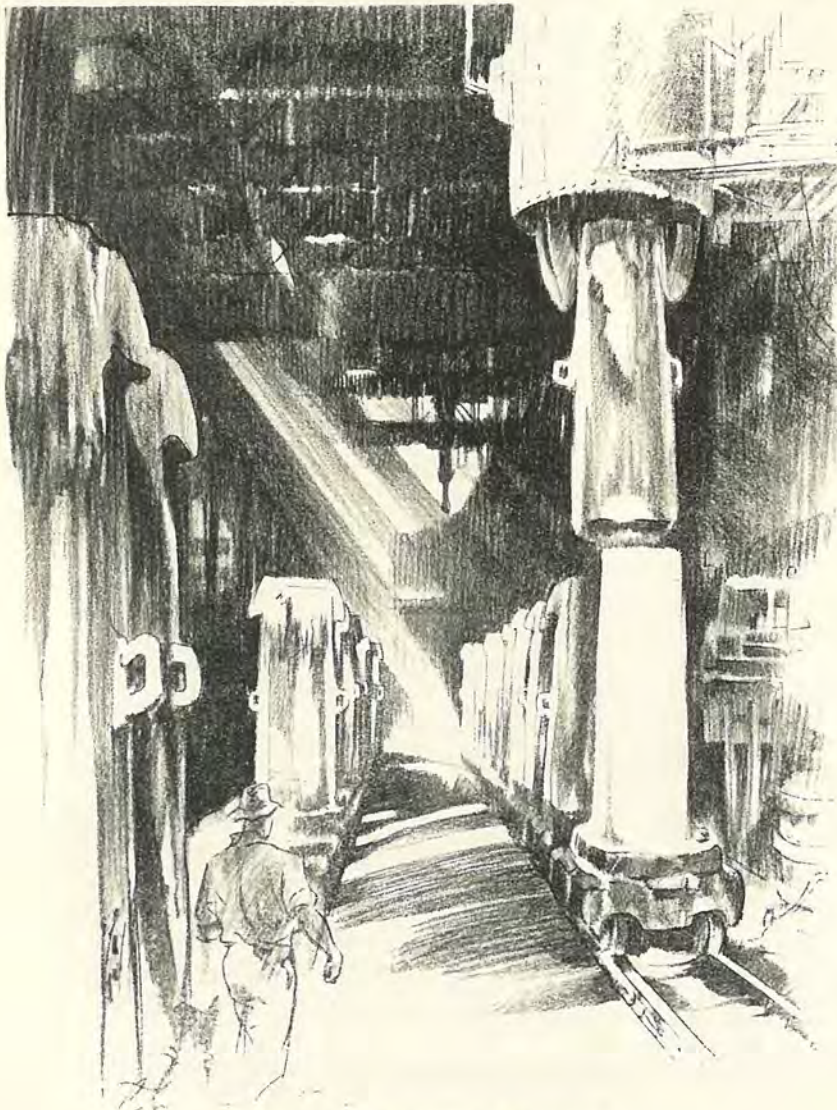
The 35 INCH BLOOM MILL is a two high reversing screw down mill, with rolls 80 inches long, driven by a reversing steam engine, capable of developing 12,000 horse-power at 140 r.p.m. The mill is equipped with roller tables, and on the front side has an hydraulically operated manipulator. This mill produces forging blooms, also blooms, beam blanks and plate slabs to be re-rolled in the 28

inch, 18 inch, and plate mills, and is capable of rolling 12,000 tons of ingots weekly.

From the bloom mill the bloom is conveyed by means of roller tables to an electrically operated down-cut shears, capable of shearing a cross section of 20 inches by 8 inches of hot steel. This shears cuts the front and back ends of the bloom to ensure that only sound steel is used for further rolling. It is also necessary, when rolling certain sections, that the bloom be cut into two or more lengths. Another electrically operated down-cut shears is provided capable of shearing a cross section of 10 by 10 ins., for cutting blooms and slabs to lengths for the 18 in. bar and plate mills.

From the shears, the bloom is delivered on to an electrically operated charging machine, which delivers it to the 28 inch mill; if it is to be re-heated, it is delivered to one of the two re-heating furnaces.

The re-heating furnaces are of the regenerative type, capable of heating blooms up to 16 feet long. They are fired by either coke-oven gas or tar. These furnaces re-heat the blooms up to the required rolling temperature, when they are drawn out by the charging machine and delivered to a travelling tilting table which conveys them to the 28 inch mill.



SOAKING PITS—STRIPPING INGOTS.



BLOOM MILL—ROLLING THE INGOT.



The 28 inch Rail and Structural Mill

THE 28 inch rail and structural mill is a 4-stand mill, three stands being three high and the fourth or finishing stand two high. The rolls are approximately 28 inches dia. by 70 inches long, with the exception of the finishing stand, which has rolls 48 inches long. The first stand is used only for rolling billets and slabs for the 18 inch continuous mill, and roughing down for 16 to 24 inch beams. For all other sections the last three stands only are used.

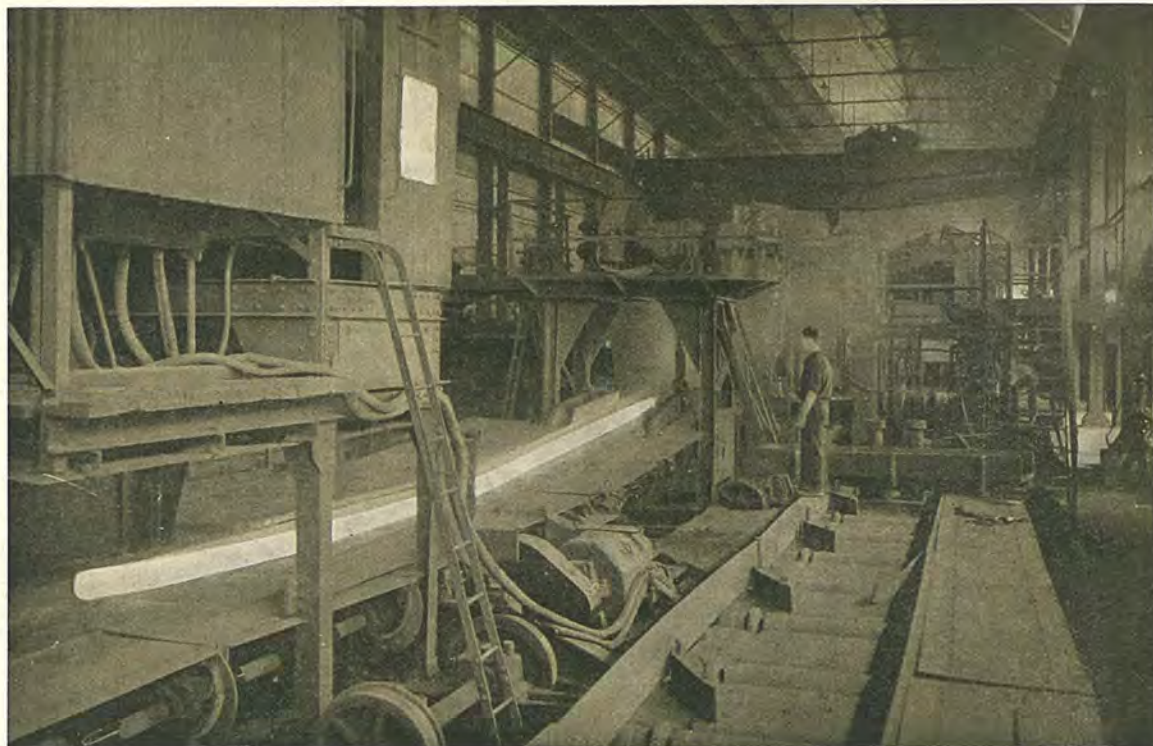
This mill is driven by a steam engine of the same size and type as the bloom mill engine. On each side of the mill are two travelling tilting tables, electrically operated, which raise and lower the bloom and shift it from pass to pass as required.

This mill produces billets and slabs for the 18 inch continuous mill, 45 to 110 lb. rails, 6 to 24 inch beams, 6 to 15 inch channels, 8 by 8 to 5 by 4 inch angles, and 14 to 18 inch flats. The rolling rate of this mill is: 45 to 110 lb. rails, 30 to 60 tons per hour; beams, channels, and angles, 20 to 40 tons per hour; billets and sheet bar, 65 to 125 tons per hour.

From the finishing stand of the 28 inch mill, the finished section is conveyed by live rollers to an electrically driven hot saw, where the product is cut into the desired lengths, after which it is stamped with the heat number, and in the case of rails cambered before being passed on to one of the three hot beds. The product is allowed to cool on these hot beds, and afterwards delivered to the finishing department, where rails are straightened, ended to length, fishplate holes drilled, and inspected before being stacked ready for delivery. Structural sections are also dealt with, straightened if required, or oiled, etc., before being put into stacks.

The loading yard is under a crane runway 982 feet long by 70 feet span, and is served by two 10-ton magnet cranes.

RAILS: Approximately one-third of the Trans-Australian railway was laid with rails from The Broken Hill Proprietary Co. Ltd.'s Newcastle Steel Works.



28 INCH RAIL AND STRUCTURAL MILL.



The 18 inch Continuous Mill

THE 18 inch continuous mill is housed in the same building as the bloom and 28 inch mills, and is about 200 feet in front of the first stand of the 28 inch mill.

A continuous mill consists of a series of roll stands arranged one after the other so that the piece to be rolled enters the first stand and travels in a straight line through the mill to the last stand, where it issues as a finished bar, thus making but one pass through each stand of rolls.

In such a mill, where the piece is being rolled in several different stands at the same time, it is necessary that the surface speed of the different sets of rolls be so proportioned that each set will travel at a speed greater than that of the preceding one, as the lengthening of the piece demands.

This mill consists of six horizontal and two stands of vertical rolls. The former are 18 ins. dia. by 20 ins. long, and these only are used for billets, the vertical rolls being used for sheet bar and flats to keep the product to the desired width.

In front of the first stand of rolls is a crop shears for cutting off the front part of the bloom or slab coming from the 28 inch mill. The mill, together with the crop shears, is driven through gearing by a 4,500 h.p. motor.

Twenty-two feet beyond the finishing stand is a steam flying shears, which cuts the product into the desired length as it emerges from the rolls. It is then conveyed by live rollers to a skew assembly plate, where billets are assembled before being delivered to one of two hot beds. Sheet bar is piled by means of a pinch roll in a piler on the skew assembly table in 10-ton lifts, after which it is lifted off and set down for cooling. The two hot beds and skew assembly table are served by one 15-ton magnet crane.

This mill produces billets from 1½ inch square to 3½ inch square from a 4 or 4½ inch square bloom, and sheet bar of 7 lbs. to 45 lbs. per foot from an 8 by 2 inch slab, and has an hourly rate of rolling of 65 to 125 tons.



18 INCH CONTINUOUS MILL.

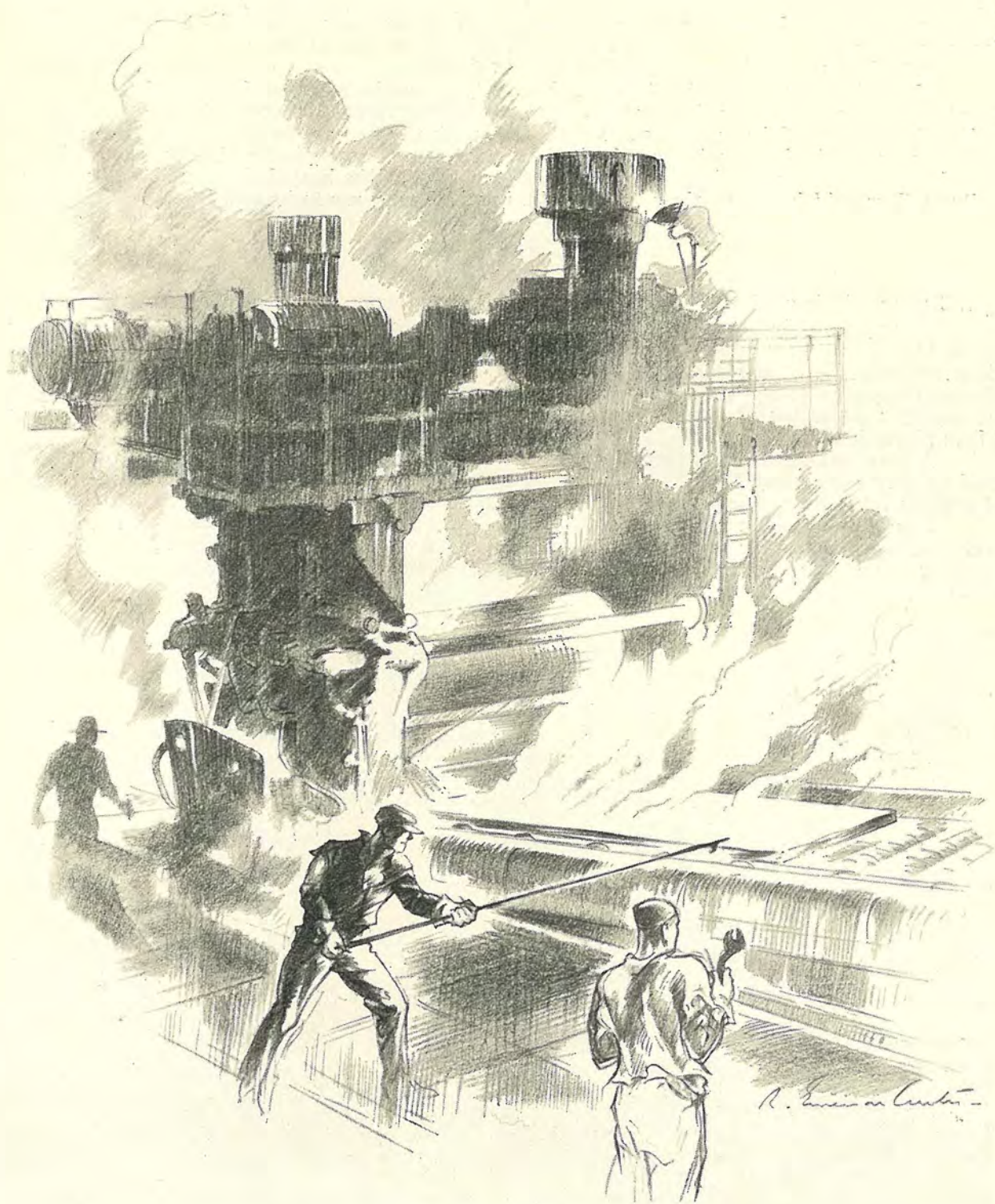


PLATE MILL—ROLLING.



The Plate and 18 inch Bar Mill

THESE mills are housed in a building 922 feet long by 70 feet span, and are served by two electric overhead travelling cranes, one of 22½ tons, and the other of 15 tons capacity, both equipped with magnets. Blooms and slabs for these mills are rolled in the bloom mill, and are delivered on specially designed cars under the crane runway, from where they are picked up and placed on a skid bed preparatory to being pushed through the re-heating furnace.

The re-heating furnace is of the continuous type, specially designed for heating either slabs for the plate mill or blooms for the bar mill. The overall length of the furnace is 50 feet, and the width inside 15 feet. The slabs or blooms are pushed through the furnace by two hydraulic rams in one or two rows as required. The furnace is fired by coke oven gas, and the air for combustion is pre-heated by means of a continuous regenerative preheater. The heated slabs or blooms are pushed on to live rollers, which convey them to the mill, in which they are to be rolled.

The Plate Mill

THE plate mill is a 34 inch by 90 inch three high continuous running mill, and is designed to roll plates up to 80 inches wide, 30 feet long, and down to 1/8 inch thick. The top and bottom rolls are 34 inches dia., and the middle roll 22 inches dia., all being 90 inches long. Tilting tables are provided on each side of the mill, so connected that they rise and fall together. The mill is driven by a tandem compound corliss valve condensing steam engine equipped with a heavy flywheel, capable of developing a maximum of 3,000 horse-power at 98 r.p.m. This mill is capable of rolling 25 tons of ½ inch plates hourly.

A plate straightener is located on the delivery side of the mill, where the plates are straightened as they come away from the mill. After straightening, the plates are piled in a piler by means of a pinch roll. From the piler the plates are transferred to the plate finishing building.

The plate finishing building is 337 feet long by 100 feet span, and is served by one electric overhead travelling crane of 15 tons capacity equipped with magnets. It is equipped with piling, marking off and castor beds, and two shears. In this building the plates are marked off, sheared to size, inspected, and made ready for delivery.



PLATE FINISHING DEPARTMENT.

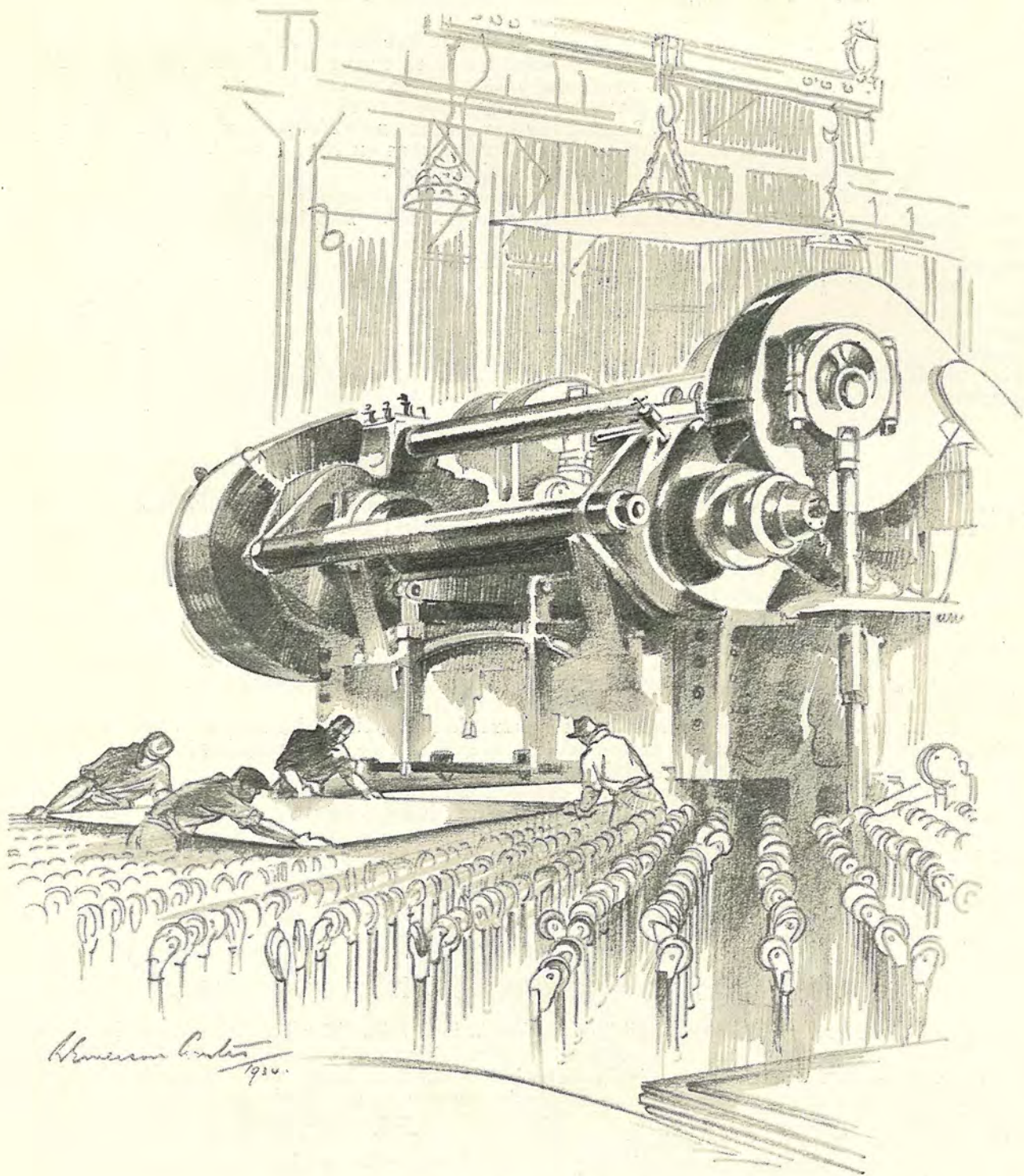


PLATE MILL SHEARS.



The 18 inch Bar Mill

THIS is a continuous running semi-tandem mill, with four stands of rolls, Nos. 1, 2, and 3 being three high, and No. 4 or finishing stand two high. Nos. 1 and 2 stands are located side by side, and Nos. 3 and 4 are tandem to No. 2.

The blooms for this mill are conveyed by the same live rollers as serve the plate mill, but at the delivery end of the table are transferred sideways to enter the first stand. Nos. 1 and 2 stands are equipped with fixed tilting tables front and back, so operated that they rise and fall together. The bars are moved from pass to pass mechanically by means of shifter bars attached to the lifting mechanism of the tables. From No. 2 stand the bar passes on to No. 3 stand by live rollers. No. 3 stand has a fixed tilting table on the front side similar to those on Nos. 1 and 2 stands. From No. 3 stand the bar passes on to the finishing stand by live rollers.

A hot saw, electrically driven, is provided where the product is sawn to the desired length before being passed on to hot beds for cooling and assembly. Two hot beds are provided, each 40 feet wide by 37 feet long. From the hot beds the product is taken to the finishing department to be straightened, punched, etc., ready for delivery to customers.

The bar mill is driven by the same engine as the plate mill, through the bottom roll of the plate mill and through spur and bevel gearing. As only one mill operates at a time, a coupling is provided between the end of the bottom plate roll and the drive for the bar mill, so that the bar mill can be coupled or uncoupled expeditiously. This mill rolls 3 in. x 3 in. to 5 in. x 3 in. angles; 6 in. x 3 in. to 4 in. x 1½ in. beams; 5 in. x 2½ in. and 4 in. x 2 in. channels; 20, 25 and 30 lb. rails; 60, 90 and 110 lb. fishplate bar; 90 and 110 lb. tie bar, and 4 in. to 12 in. flats. It has an hourly capacity of 30 tons.

The 12 inch Mill

THE 12 inch mill has five stands of rolls. The first four stands are three high, with rolls 12 inches diameter. These four stands are driven by a vertical corliss valve cross compound steam engine, capable of developing 1,100 horse-power at 150 lbs. steam pressure and 98 r.p.m. The fifth or finishing stand is located about 97 feet in front of the fourth stand. It is a two high stand with 12 inches diameter rolls, and is driven by a 250 horse-power electric motor.

This mill is housed in a building 360 feet long by 70 feet span, and is served by one 10-ton electric overhead travelling crane.

The re-heating furnace is of the continuous recuperative type, with a hearth 40 feet long by 10 feet wide. It is fired by coke oven gas. The billets are pushed through the furnace by hydraulic cylinders on to live rollers, which convey them to the mill.

After leaving the finishing stand, the product is conveyed by live rollers on to a hand operated hot bed, where it is allowed to cool before being conveyed to a shears for cutting to length. It is afterwards piled ready for delivery to the finishing and loading department.

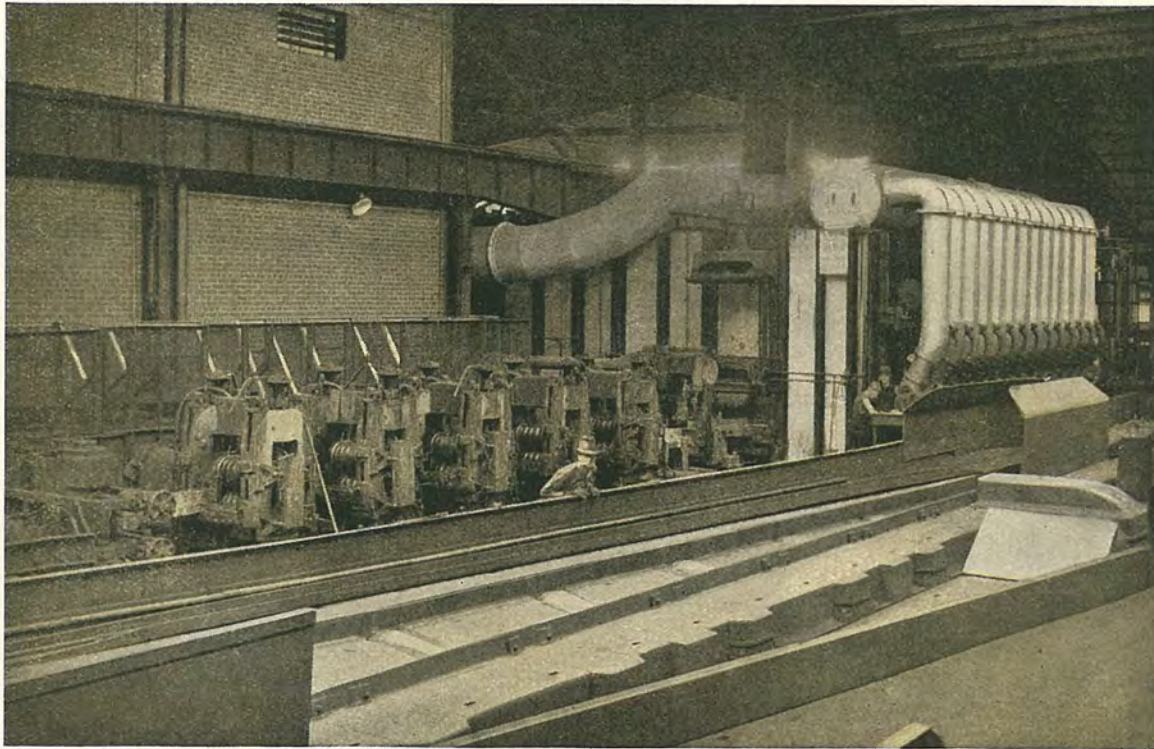
Billets for this mill, and also for the combination merchant, strip and skelp mill, and the rod mill, are supplied by the 18 inch continuous mill, which delivers them to a billet yard, where they are stacked until ready for use. This billet yard is served by one 10-ton electric overhead travelling crane, and is also equipped with a shears for cutting suitable length billets for the 12 inch mill.

On this mill are produced 14 lb. rails, fishplate bar, channels 3 in. x 1½ in., octagons ½ in. to 1½ in., round and square edge flats 1 in. to 6 in., rounds and squares ½ in. to 2 in., angles 1½ in. x 1½ in. to 3 in. x 2½ in., also tees 1 in. and 1½ in. by ⅝ in.

The Combination Merchant, Strip and Skelp Mill

THIS mill is housed in the same building as the 12 inch mill. The heating furnace is of the continuous recuperative type and is designed for a maximum output of 35 tons of finished product per hour. The effective hearth area is 32 feet wide by 39 feet long. The billets are placed in the furnace by pinch rolls, and pushed down the sloping hearth to the discharge door, whence they are pushed out when heated. At the mill side discharge door are located a pair of reversible pinch rolls, which feed the billets into the mill or return unentered billets to the furnace. The furnace is fired by coke oven or producer gas, or a mixture of both. The air for combustion is preheated by means of a metal recuperator.

In front of the pinch roll for entering billets to the mill is a pendulum shears for shearing to short lengths when necessary. In front of this shears is the continuous roughing mill, consisting of one set of edging rolls 12 inches diameter, followed by five horizontal stands of rolls, Nos. 0-4, 14 inches diameter and one stand of 12 inch edging rolls. Following this is a drop looping table used for rolling skelp or strip. This drop looping table is a combination table with a drop looper and guides, so



REHEATING FURNACE AND CONTINUOUS BAR AND STRIP MILL ROUGHING STANDS.

that when rolling skelp or strip the drop looper can be used. When rolling merchant bar, the table can be moved sideways and merchant bar rolled through the guides. In front of this is the continuous intermediate mill, consisting of four horizontal stands of rolls, Nos. 5-8, 12 inches diameter, and one stand of 12 in. edging rolls.

In front and to one side of the intermediate mill, is the finishing mill, consisting of four stands of horizontal rolls, Nos. 9-12, in groups of two in staggered formation, the first two having



CONTINUOUS BAR AND STRIP MILL—FINISHING STANDS.



12 inches diameter rolls and the last two 10 inches diameter rolls. The last two stands are used for rolling the smaller sizes, and can be moved into line with the last of the 12 inch stands, making three stands continuous for rolling strip.

Between the last finishing stand and the cooling bed is located a Rendleman type of rotary disc shears for the purpose of dividing the smaller sections rolled into cooling bed lengths. This shears will cut rounds up to 1 inch diameter, and flats up to 2 in. by $\frac{1}{4}$ in.

About 280 feet away from the last finishing stand is located the cooling bed. This bed is entirely mechanical of the Morgan single carry-over type, is 240 feet long, and made in two halves, so that either half can be operated, or the two together as a single unit.

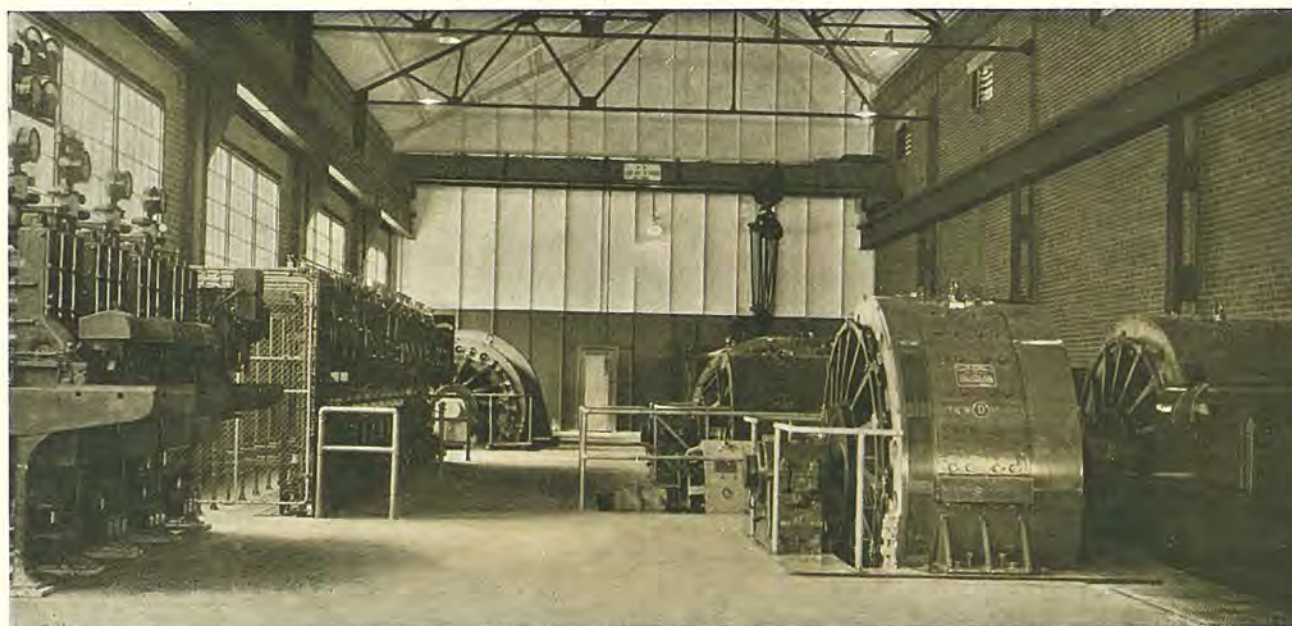
From the cooling bed the product is delivered to a bar shears, equipped with a knife 30 inches wide. From the shears the product is delivered on to the back shear table and kicked off into cradles ready for assembly. If the product has to be bundled, it is delivered to a rotary bundling machine, and bundled ready for delivery. Skelp and wide strip are rolled in the roughing and intermediate mills, and delivered through a vibrator to an apron conveyor, whence they are fed into coilers. From the coilers a conveyor takes the coils to the loading crane.

For small rounds and squares, pouring reels are provided adjacent to the finishing mill. These pouring reels are capable of coiling rounds from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. diameter, and sections of equivalent area. The coilers deliver the product to a conveyor, which in turn delivers it into the loading yard.

Narrow strip rolled in the finishing mill is delivered through a vibrator on to an apron conveyor, from which it is fed into the same coilers as used for skelp. These coils are delivered in the same manner as skelp. Skelp and wide strip are finished in the intermediate mill at speeds varying from 292 to 876 feet per minute. All other products are finished in the finishing mill at speeds varying from 480 to 1768 feet per minute.

This mill is electrically operated throughout by 9 motors, varying from 300 to 1200 h.p., totalling 6900 h.p. A motor generator set, consisting of two 1750 k.w. D.C. generators, driven by a 4330 k.v.a. A.C. synchronous motor, is provided for driving the main mill motors and to enable voltage control to be used.

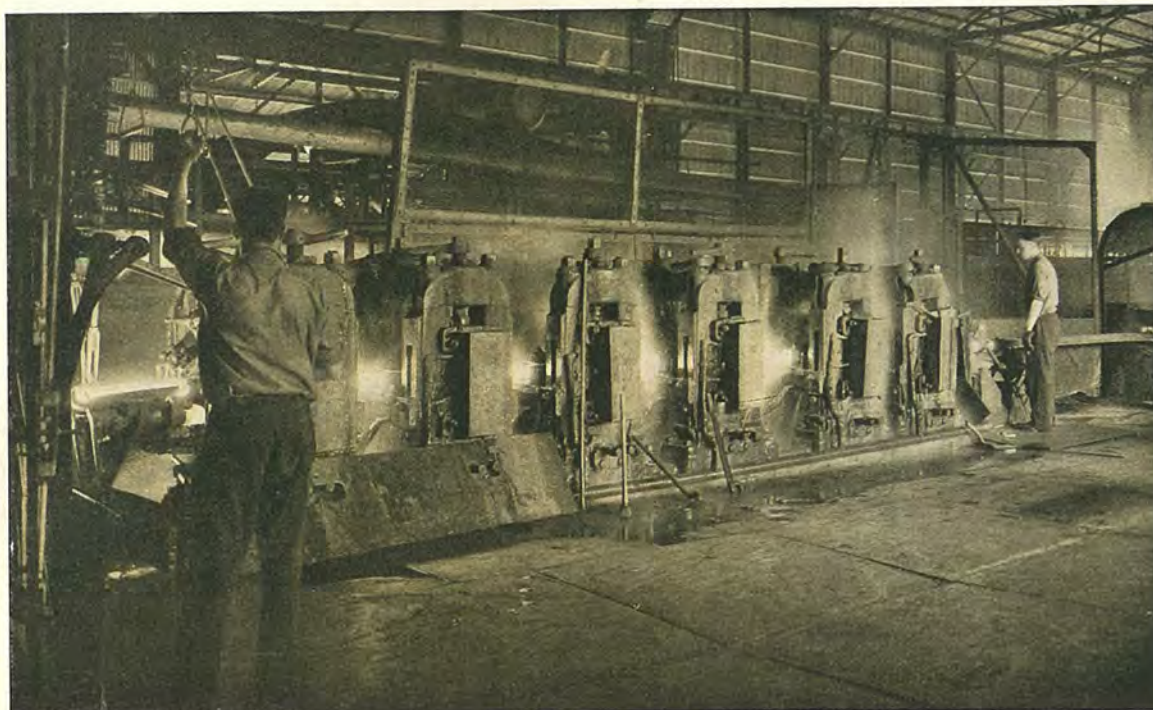
This mill is capable of producing rounds from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in., squares from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in., angles from $\frac{3}{4}$ in. x $\frac{3}{4}$ in. to 3 in. x 3 in. by $\frac{1}{8}$ in. to $\frac{5}{8}$ in. thick, pack annealed spring flats up to 4 in. wide, merchant flats up to 6 in. wide, skelp and strip 1 in. to 8 in. wide, beams and channels up to 3 in. and 14 and 18 lb. rails. Skelp, and rounds from $\frac{1}{4}$ in. to $\frac{3}{8}$ in., can be delivered in coils or straight lengths; also sections of equivalent area. All other products, with the exception of strip, are delivered in straight lengths.



CONTINUOUS BAR AND STRIP MILL—MAIN MOTOR ROOM.



The Rod Mill



ROD MILL ROUGHING STANDS.

THE rod mill is housed in a building 225 feet long by 82 feet wide, and is served by one 10-ton electric overhead travelling crane. Billets for this mill are supplied by the 18 inch continuous mill, and are $1\frac{1}{4}$ in. x $1\frac{1}{4}$ in. x 30 feet long. These billets are unloaded in the billet storage yard and placed on a billet bed, whence they are fed into the heating furnace.

The heating furnace is of the continuous recuperative type, with an effective hearth area of 32 feet wide by 25 feet long, the roof being of the suspended type. It is fired by either coke oven or producer gas. Billets are charged into the furnace by a pinch roll, pushed through the furnace by a steam cylinder, and discharged by a bar operated by a pinch roll.

The mill is of the Morgan continuous type, and consists of 16 stands of rolls, arranged in batches of six and ten. The first six comprise the roughing mill, and have chilled cast iron rolls, 12 inches nominal diameter. The last ten comprise the finishing mill, and have chilled cast iron rolls 10 inches nominal diameter.

Between the furnace and the first stand of rolls is an emergency shears for cutting the billet in case of a cobble, and at the end of the roughing train is placed a steam flying shears for cropping the end of the bar before it enters the finishing mill.

The mill is driven through spur gearing and belts by a cross compound horizontal corliss valve condensing steam engine, which, at 96 r.p.m., develops 3500 horse-power.

A scaler is provided between the finishing pass and the coilers. All rods from this mill are rolled double strand and coiled, four coilers being provided, driven through belting by the mill engine, and the speed being varied to suit the product rolled by means of step pulleys.

From the coilers, the bundles are dropped on to a bundle conveyor, which delivers them to a cooling and delivery conveyor, whence they are hooked off and placed on trucks for delivery to the wire works. Both these conveyors are operated by variable speed motors.

Adjacent to the delivery conveyor are three Schuster bar straightening machines for straightening and cutting to lengths for concrete reinforcing bars. These machines can cut up to 45 feet long.

This mill rolls rods from 7/0 gauge ($\frac{1}{4}$ in. dia.) down to No. 5 gauge (.212 in. dia.), and has a capacity of 18 tons per hour of No. 5 rods to 24 tons per hour of No. 7/0 rods.



ROD MILL COOLING CONVEYOR.

The Fish and Tie Plate Mill

THE fish and tie plate mill is located adjacent to the merchant mills loading yard. The feed for this mill is rolled in the 18 inch bar mill in long lengths, and hot sawn to lengths of 20 to 22 feet. These bars are placed on a stock bed by the 18 inch mill crane, from where they are fed to a shears, which cuts the bar into the lengths required. The sheared product is delivered to the heating furnace by a gravity conveyor.

The heating furnace is of the continuous recuperative type and is fired by coke oven gas. The effective hearth area is 33 feet long by 4 feet wide. The bars are pushed through the furnace by an hydraulic cylinder and are end discharged on to a table. From this table the bars are picked up and put through the punching machine, from which they are delivered by means of a gravity conveyor to a notching machine. After being notched, the bars are put on a driven roller chain conveyor and delivered to an hydraulic press, where they are straightened. From the press they are pushed on to a disappearing finger conveyor, hydraulically driven. Tie plates are then taken off, inspected, bundled and delivered to the merchant mills loading yard for despatch. Fish plates are conveyed by the conveyor to an oil bath, where they are dipped in oil and then discharged on to a table. From this table they are picked up, inspected, bundled, and then delivered to the merchant mills loading yard for despatch.

MERCHANT MILLS LOADING YARD AND WAREHOUSES

THE merchant mills loading yard and warehouses are located at the delivery ends of the 18 in. bar, combination merchant strip and skelp and rod mills. The loading yard is covered by a crane runway 877 feet by 90 feet, and served by two 10 ton electric overhead travelling cranes. Of this runway, 300 feet is roofed over and used as a warehouse. All the material rolled in the 18 inch bar, 12 inch and combination merchant strip and skelp mills, with the exception of skelp, wide strip, fish and tie bar, is delivered to this yard to be finished and made ready for delivery. This yard is equipped with storage racks, inspection beds, two shears, two vertical gag presses, one horizontal gag press, three angle straighteners, two punches, and one ender. Five railway lines serve the yard for shipping.

Adjacent to the loading yard are two covered warehouses. The larger one is 347 feet long by 105 feet span, and is equipped with one 10-ton electric overhead travelling crane, storage racks, and inspection beds. A transfer car is provided for transferring material to the loading yard or vice versa. This building is served by a railway line, so that material can be shipped.

The smaller warehouse is 100 feet long by 67 feet span. It is equipped with one 5-ton electric overhead travelling crane, and storage racks for one ton lots. This warehouse is used solely for alloy steels. Material for prompt shipment is kept in the loading yard, whilst for deferred shipment it is transferred to one of the warehouses.



The Alloy Bar Pickling Plant

THE alloy bar pickling plant is adjacent to the merchant mills loading yard, from which it draws its supplies. It is housed in a building 347 feet 6 inches long by 86 feet 6 inches span, served by one 10-ton electric overhead travelling crane. About half the building is used for the pickling plant. It is equipped with storage and chipping beds, one pickling and one washing tank. A transfer car is provided for transferring material to and from the loading yard. Alloy steel is pickled and washed, and any defects in the steel are chipped out.

The Steckel Mill

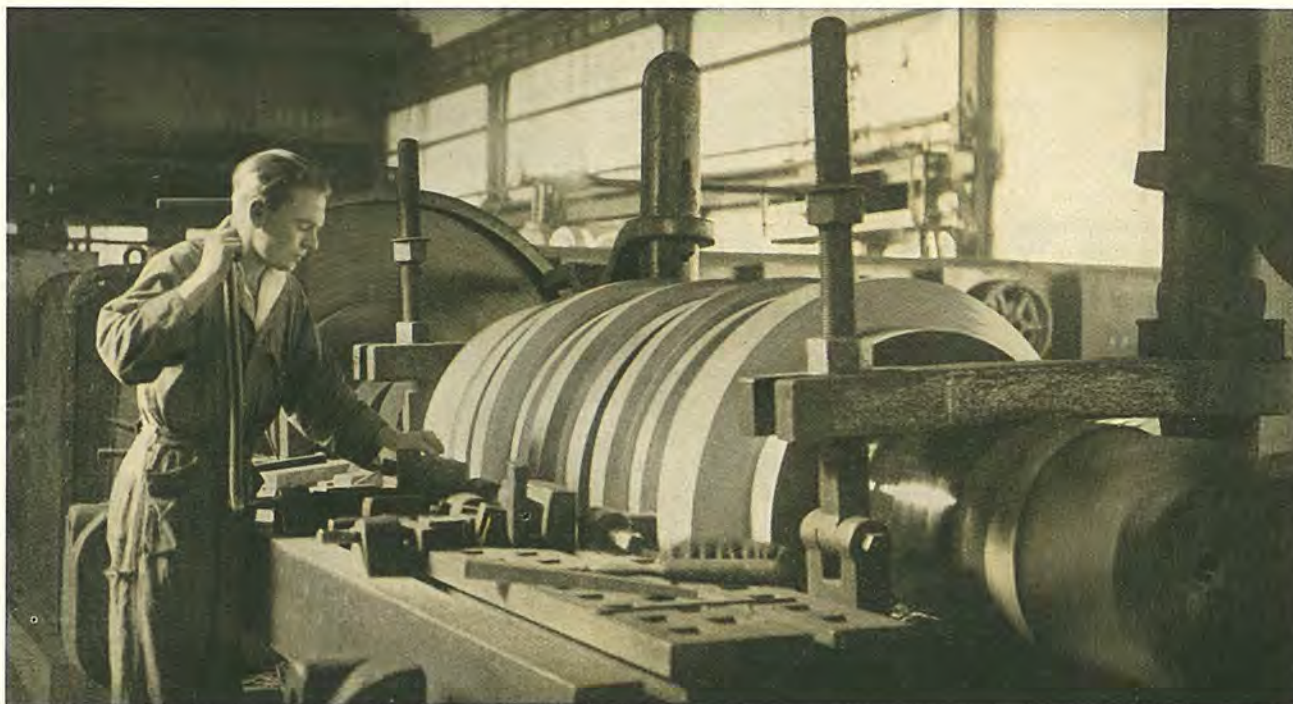
THE Steckel mill, housed in the other half of the alloy bar pickling plant building, is a precision machine for rolling exceedingly thin strip of very high quality, gauge accuracy, and finish. The mill consists essentially of two small working rolls, backed by two much larger rolls, two freely rotating coiling drums, over which the strip passes in travelling from the working rolls to the reels, two reels, and the necessary gearing and means for adjusting the draft. The strip is drawn through the rolls and wound up by the leading reel, whilst it unwinds from the other, the trailing reel. Thus all power for rolling is applied through the strip itself. A further requirement is the use of back tension on the strip. This is necessary to obtain a flat smooth strip of the proper quality and finish, and is an inherent feature of the rolling process. In addition, this prevents the trailing reel from over-running and unwinding too fast. For the present, this mill will produce strip of No. 1 temper, a full hard cold rolled bright strip up to 7 in. wide and down to .002 in. thick.

One 8 inch slitte is provided for slitting the wide strip into any number of narrow widths.

For the production of narrow hot rolled black strip in coils or cut lengths, a slitte and rotary flying shears have been provided. The slitte slits the wide strip obtained from the strip mill to the width required, and the rotary flying shears cuts the coils into lengths as ordered.

Roll Turning Shops

TWO roll turning shops are provided. One shop, situated adjacent to the 35 inch bloom and 28 inch mills, turns all the rolls used in these mills and also for the plate mill. The other, located between the combination merchant strip and skelp mill and the 18 inch bar mill, is used for turning rolls for the 18 inch bar, combination merchant strip and skelp, 12 inch and rod mills.



ROLL TURNING.



BOILER and POWER PLANTS

Steam used for both power and general process work is generated in four separate plants which are close to the point of steam utilisation. Brief particulars of each plant are as follow:—

Blast Furnace Boiler Plant : This plant consists of 14 water-tube boilers, six having a heating surface of 6,182 square feet each, and the other eight a heating surface of 5,540 square feet each. These boilers are equipped with integral superheaters for 100 deg. superheat, and are provided with Birkhulz-Terbeck burners for firing with blast furnace gas. Grates are provided for emergency hand-firing with large coal during blast furnace delays. Steam is generated at 160 lbs. per square inch, and supplied to blast furnace blowing engines, main salt water pumps, blast furnace auxiliary steam units, and open hearth gas producers, etc. Any surplus steam generated is distributed to the main 28 in. mill boilers, via a 12 in. inter-connecting main, whilst in the event of shortage steam may be supplied from main mill boilers or A.C. power plant boilers, which are also connected to the 160 lbs. steam pressure system.

A.C. Power Plant Boilers : There are at present four water-tube boilers in this plant, each having a heating surface of 9,273 square feet, and equipped with integral superheater and blast furnace gas burners. Three of the boilers are also fitted with unit system pulverised fuel equipment of the Impax type, the pulverisers having a capacity of 5,000 lbs. of coal per hour. Each pulveriser is direct-coupled to a 70 h.p., 440 volt, 1450 r.p.m. A.C. motor.

The fourth boiler is fitted with a grate for auxiliary hand firing, but arrangements are now being made to instal a pulveriser on this boiler, and also to erect a fifth boiler. The additional boiler will be of the same nominal heating surface, viz., 9,273 square feet, and will be equipped for both pulverised fuel and blast furnace gas firing, with forced and induced draft and air pre-heater. The maximum evaporation will be 60,000 lbs. per hour, or 50 per cent. more than each of the existing pulverised fuel-fired boilers. The steam, which is generated at 200 lbs. per square inch, is supplied to the A.C. turbo-generators, and any surplus is allowed to pass via a special reducing valve to the 160 lbs. per square inch pressure system.

The Main Mill Boiler Plant : This plant contains 12 water-tube boilers, each having a heating surface of 5,540 square feet, and fitted with superheater. These boilers are equipped with chain grate stokers, two of the stokers being specially arranged for burning coke breeze. Two additional stokers for breeze burning are now being installed. The combustion chambers of the coal-fired boilers are arranged for burning a small quantity of coke oven gas whenever there is a surplus.

The steam is generated at 160 lbs. per square inch, and this plant supplies the bloom and rail



MAIN MILL BOILER PLANT.

mill engines, D.C. generating sets, main air compressor of 2,200 cubic feet capacity, hydraulic pumps, soaking pit gas-producers, and various services in the steel foundry and the workshops.

Merchant Mill Boiler Plant: This plant comprises 11 boilers of 5,540 square feet heating surface, which are equipped with integral superheaters. Six of the boilers are arranged for burning coke breeze; two are fitted with modern pressure type coke oven gas burners, and the remaining three with ordinary coal-burning chain grate. The steam which is generated at 160 lbs. per square inch, supplies the plate and bar mill, 12 in. mill, and rod mill engines, and auxiliaries, also the coke ovens plant, benzol plant, and tar distillery.

A.C. Power Plant: Installed in the A.C. power house there are two 5,000 k.w. 6,600 volt, 25 cycle, 3 phase, 1,500 r.p.m. turbo-alternators. The condensers have a cooling surface of 11,480 square feet each, and the cooling water is supplied by two 42 inch bi-rotor single stage centrifugal pumps, direct coupled to 600 h.p. A.C. motors. Only one pump is used at a time. Each pump is capable of delivering 30,000 gallons per minute against a head of 45 feet. Low voltage for auxiliaries is obtained from two shell type 3 phase 250 k.v.a. 6,600/440 volt transformers.

Main D.C. Sub-station: This was the original power plant, and only became a sub-station after the erection of the A.C. power plant about nine years ago. It contains three 500 k.w. 250 volt D.C. generating units, and three 1,000 k.w. motor generating sets. The three 500 k.w. generators are driven by vertical steam engines fitted with condensers, but these sets are now only used as a standby. Of the three motor generators, two are driven by 6,600 volt salient pole synchronous motors, and one by an auto-synchronous motor, excitation being obtained from the D.C. generator.

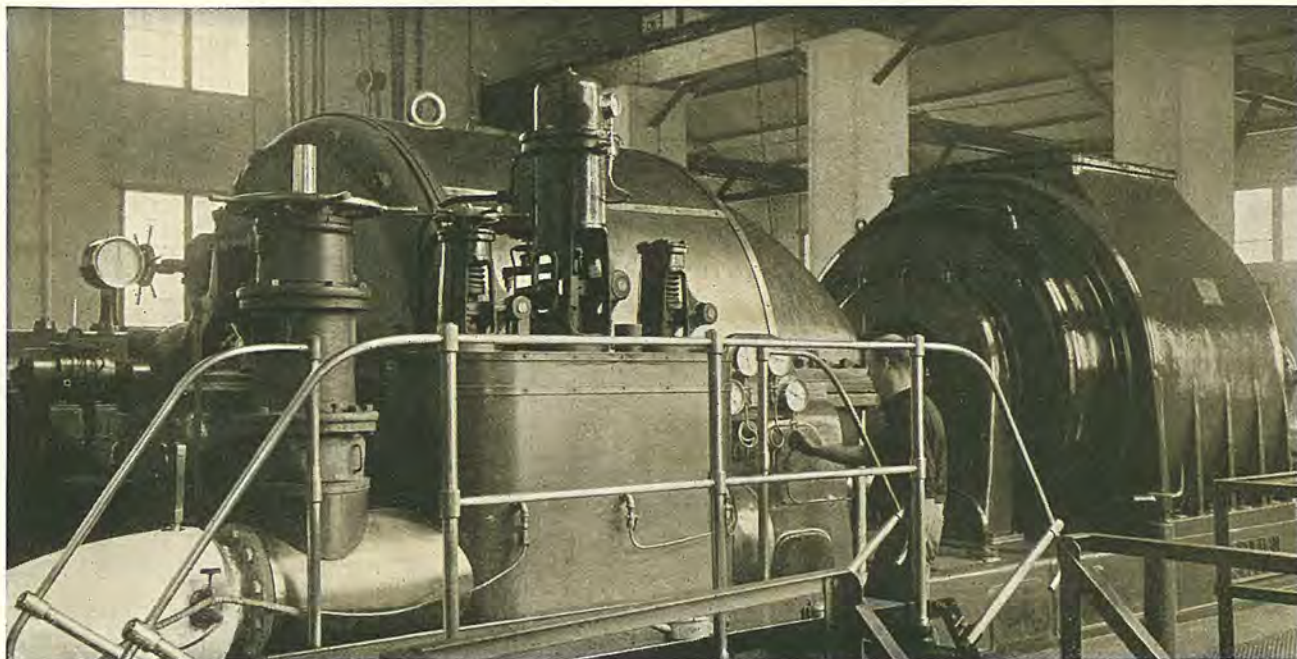
The Coke Ovens Sub-station contains a 1,000 k.w. 660 volt synchronous motor, 250 volts D.C. generating set, and four three-phase 500 k.v.a. 6,600/440 volt transformers. This sub-station supplies 440 volt 3 phase A.C. and 230 volt D.C. to the coke ovens section of the works.

Distribution: The 6,600 volt alternating current is carried by three core lead-covered armoured cables laid underground. The supply to the sub-stations is by means of a ring main from the A.C. power house. The 440 volt alternating current and the 250 volt direct current are carried on poles overhead, the sub-stations being inter-connected by a 250 volt D.C. ring main.

Motors: The number of electric motors installed at the steel works is 1,150, ranging from 1/8th h.p. to 4,500 h.p.

Main Salt Water Pumping Plant

The original pumping plant contained three 18 inch centrifugal pumps direct driven with 205 h.p. D.C. motors. As the demand for water increased, three 30 inch steam driven centrifugal pumps were added. The 18 inch pumps have a capacity of approximately 4,500 gallons per minute, and the 30 inch pumps 12,500 gallons per minute, against a total head of 80 feet. The water is pumped into two 220,000 gallon overhead storage tanks.



POWER PLANT—5,000 K.W. TURBO-ALTERNATOR.



STEEL FOUNDRY



THE STEEL FOUNDRY.

FURNACE and foundry sections form the main divisions of the steel foundry. In the former are two open hearth steel furnaces each of 35 tons capacity. One is known as the acid open hearth, the lining of the furnace bath being made of a siliceous sand. The other is known as the basic open hearth, the lining of the bath being of a basic material such as magnesite or dolomite.

These furnaces are housed in a building which is offset from the main building, and are so placed that the metal from the tapping side runs into ladles in the main building, where it is handled by electrically operated cranes provided for the purpose.

The furnaces are equipped with an electrically operated overhead charging machine of $3\frac{1}{2}$ tons capacity, as well as an electrically operated magnet crane of 20 tons capacity. The latter traverses the stockyard where the necessary charges of pig iron, scrap and fluxes are prepared and delivered to the furnace floor, prior to being charged into the furnace.

Both furnaces are fired by producer gas from mechanical gas machines conveniently situated near the furnaces.

Several grades of plain carbon steel are made. They are: mild steel forging, axle, spring, rope and special steels, all of which are poured into ingots of approximately $3\frac{1}{4}$ tons in weight, big end up and hot-topped.

In addition to the above plain carbon steels, two sizes of tyre-steel ingots are produced. These are: twelve-sided fluted ingots, being of 12 inch and 15 inch nominal diameter, and weighing approximately 24 cwts. and 39 cwts. respectively. These ingots are all hot-topped and bottom-poured in groups of six through specially shaped runner bricks made of refractory fireclay. These ingots are later delivered to The Commonwealth Steel Company Ltd., where they are processed into railway tyres.

Various grades of alloy steels are also made: nickel, nickel-chrome, chrome axle, chrome spring and silico-manganese spring steels. These are poured into hot-top ingots, big end up, weighing approximately $3\frac{1}{4}$ tons.



Large forging ingots are also made in sizes varying from five to 20 tons in weight, in specially designed moulds of which there are four sizes viz.: 24 inch, 30 inch, 36 inch, and 42 inch diameter. These ingots are octagonal and fluted in shape. They are used extensively for large forgings of various descriptions. A large quantity was used for the tail shafts and other large forgings for the ships which have been built in Australia.

The foundry section, in which the steel castings and rolls for the various mills are made, is housed in the main building. It is equipped with two 50-ton electrically operated cranes which serve the moulding section, and the assembling of the ingot moulds and stools. They also deal with the molten metal as it comes from the furnace.

Steel castings of various descriptions, some up to 30 tons in weight, are made for the maintenance and repair of the several units of the plant as well as for the additions made from time to time. Steel castings are also made for outside firms. These conform to Lloyds, or to any government, specifications for steel castings.

In addition to the steel castings, plain carbon steel rolls, alloy steel rolls, and chilled iron rolls are made for the various rolling mills. These vary in weight from seven cwt. to 25 tons. All of them require special care and attention in manufacture.

The whole of the steel castings and rolls, with the exception of chilled iron rolls, are subjected to an annealing process during which the casting strains are removed and the grain is refined, thereby producing a tougher and more serviceable product. This process is carried out in annealing furnaces, of which there are two, and which may be either gas or tar fired.

The foundry section is provided with the necessary grinding and screening mills, for the preparation of the moulding sand, in addition to the drying ovens and core stoves necessary for the drying of the mouldings before they are closed and ready to receive the molten metal.

After annealing, the adhering sand is removed from the castings and rolls. They are then delivered to the machine or roll shops, where they are machined and finished.

Direct Metal Foundry

The direct metal foundry is a works service unit; that is, it keeps up the supply of iron castings required by the other departments. Its product is not manufactured for sale, but to deal with the heavy wear and tear of steel works machines and equipment.

The name direct metal implies that the iron comes "direct" from the blast furnace to the foundry in its molten state, and does not go through the usual processes of being moulded into pig iron and remelted in a cupola as in ordinary foundry practice.

The molten metal arrives by works railway in large ladles holding up to 38 tons. The foundry ladles are filled from railway or blast furnace ladles by means of overhead cranes. This is effected by tilting the ladles on their own undercarriages.

The foundry is equipped for both light and heavy work, massive or intricate castings. Castings weighing 60 tons and a great deal more, if desired, could be produced. Articles have been made ranging in weight from one pound to 34 tons, but the usual daily practice is seven pounds to five tons, or, in the phraseology of the moulder, "from doll's eyes to anchors."

The product chiefly consists of machine parts, furnace castings, floor plates, open hearth and steel foundry equipment, e.g., ingot moulds and stools, ingot car bodies, and blast furnace equipment, such as slag pots and pig moulds. In addition a great deal of pipe work is turned out.

In recent years a small cupola in this foundry has been dealing with the modern demand for still further special grades of pig iron, and irons of an alloy nature. These are known as synthetic irons, and are really made by melting different grades of pig together and making the necessary alloy additions.

There is no finer foundry building in the Southern Hemisphere. Its lighting is ideal for both day and night work, while its height—some 60 ft. to roof trusses—assures ample head room and perfect ventilation. It is already equipped with 60 ton, 20 ton, and 10 ton overhead gantry cranes, while provision in the design and strength of the building has been made for an additional overhead crane and several cantilever type travelling wall cranes.

The shop has been carefully laid out, and since the personnel takes great pride in maintaining its cleanliness and orderliness, its general appearance is unequalled in the Commonwealth or in many other countries.

During twelve years of operation just completed, 82,278 tons of castings have been produced. This output comprised 141,098 different pieces, all of which have been consumed at the works.



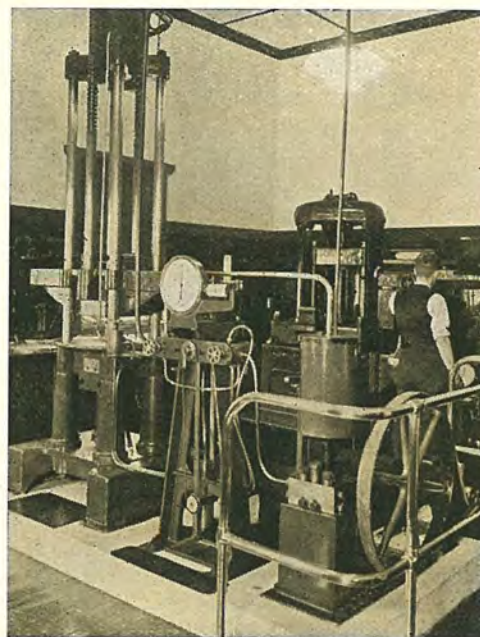
TEST HOUSE and CHEMICAL LABORATORY

SO that the consumer may be assured that the products purchased are exactly according to his requirements, all the manufacturing processes are subjected to up-to-date scientific control.

The function of the Test House and Chemical Laboratory is to assure that the steel products are turned out to specification and that the materials used in the manufacture of iron and steel are suitable for the purpose. In the metallurgical processes the chemical laboratory functions as both a control and proving unit, samples being taken and analysed as the processes proceed.

It is the laboratory's responsibility to determine the percentages of the constituents of the finished product. In addition it supplies chemical information to the metallurgists and engineers, without which they would be unable to operate their departments efficiently or solve their many problems.

The Test House functions in much the same way, but as its name implies it pays attention to the physical testing of the finished product and is the controlling unit in determining whether a steel is suitable or not for filling any particular order. The Test House is well equipped with modern appliances and instruments for scientific control and research. Thus it is able to determine that the steel is true to specification before it passes on to the purchaser. This department, being staffed with metallurgists and trained inspectors, also assists the customer to solve his problems.



PHYSICAL TESTING MACHINES.



THE LABORATORY.



SERVICE DEPARTMENTS

AS auxiliaries to a steel works there must necessarily be a large number of trade shops in which practically every phase of modern engineering is carried on. In Newcastle these shops are known as service departments, since they serve the production departments and the works generally.

The function of these units is to construct, maintain, and repair anything that operations may demand. Their work ranges from the construction of steel-framed buildings, locomotives and machines, through the art of the pattern maker and moulder down to ironworkers, carpenters, and tinsmiths, and into the realm of railways, electrical power, brickmaking, transportation, and general supplies.

These units are, of course, indispensable to the life of the works. They do not shine brilliantly with production records, but nevertheless their efficiency is the very source from which these records come.

Approximately 1,900 men are employed in these departments.

Machine Shop

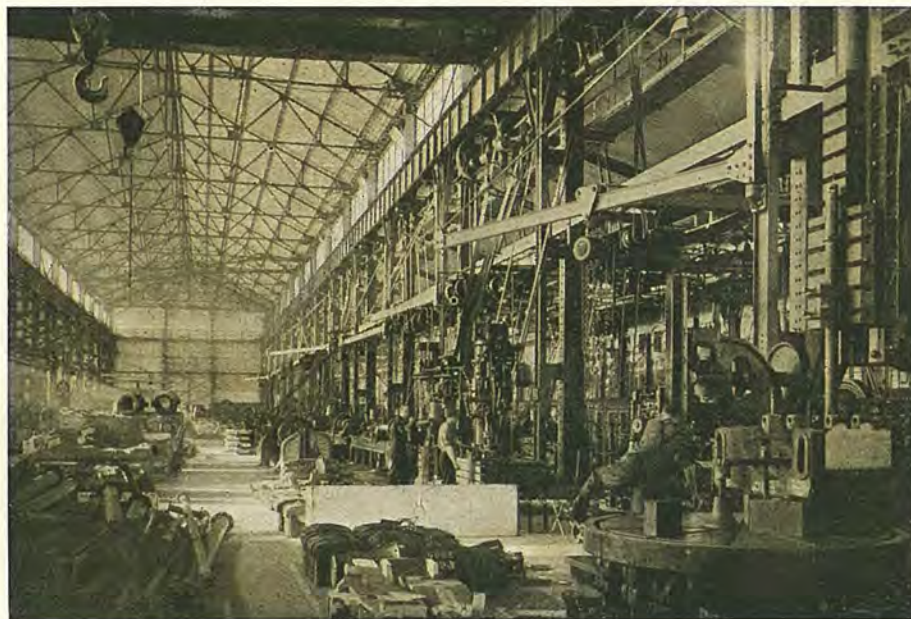
The equipment of the machine shop has been specially selected to cover a wide variety of work, and is housed in a modern building having a central bay 400 ft. long by 50 ft. wide, with 25 ft. bays running full length on either side.

The overhead electric crane in the main bay is capable of lifting 50 tons on the main hoist and 25 tons on the auxiliary.

Among modern heavy, medium, and light machine tools comprising the plant are included:—

Three planing machines, the largest having a capacity of 23 ft. x 5 ft. 6 in. x 5 ft. Three slotting machines, the largest with a stroke of 30 in. Two modern vertical boring machines. One horizontal boring machine. Two modern turret lathes. Thirty engine lathes, the largest of which is capable of machining a shaft 2 ft. 6 in. in diameter and 29 ft. long.

In addition, there are numerous other machines which meet all the requirements of a modern machine shop.



THE MACHINE SHOP.

A section of the shop is set apart and fitted up with small machines for the purpose of manufacturing and repairing gauges and small tools requiring precision.

One of the latest additions to the equipment, which brings the shop to the forefront in oxy-burning, is a modern oxy coke-oven gas profiling machine.

The demands made on this shop are exceedingly varied. It has turned out locomotives, large cranes, heavy presses, mechanical rolling stock, and heavy and light mill parts. While it handles much of the development and construction work, it is essentially a maintenance and repair shop.

Hygiene and comfort of the workers are served by a well equipped change house, and luncheon room with all modern conveniences. Every man of the present labour force (220) has his own steel locker, and may sit at table for the midday meal.



Fabricating Shop

Perhaps no other trade has had to adapt itself with greater thoroughness to new methods than that of steel fabrication. Electric welding brought radical changes in its technique.

The equipment at the Newcastle shop is such that almost any job can be efficiently done according to modern practice.

The variety of work turned out daily is probably unequalled in any other shop in Australia, and, because of this wide range, the name of the department was changed from Boiler Shop to Fabricating Shop. Anything and everything made of steel plates and sections is fabricated.

No job has been too large or too small for the department. It has fabricated our largest buildings, tallest chimney stacks, largest side dumping railway cars, 80-ton open hearth ladles, locomotives, and ships' boilers, benzol tanks, crane girders, and large welded tar and benzol stills.

While its responsibility is mainly efficient maintenance, it handles construction programmes whenever demand is made.

Brick Plant

Magnesite, i.e., magnesium carbonate, constitutes one of the most important refractories used at a steel works. The company obtains the majority of its requirements from quarries at Fifield and Attunga in N.S.W.

Under normal conditions, 950 tons are used per month, 650 tons being calcined for the maintenance of the bottoms of steel furnaces, and 300 tons converted into bricks. The brick plant consists of three kilns: one whose capacity is equivalent to 34,000 standards, one of 15,000 standards, and the third of 16,000 standards. The equipment includes three ten-foot solid bottom grinding pans, one jaw crusher, one 18 in. pug mill, three hand presses, and one wire type cutting machine.

The magnesite is first crushed and then moulded into a rough shaped brick. This rough brick, after partial drying, is charged into a kiln for preliminary burning for the purpose of reducing the carbonate to oxide and promoting shrinkage which takes place during conversion. This burned material is again ground, moulded and finally pressed into a true shaped brick. After from seven to ten days' drying, these bricks are again charged into a kiln and burned, but at a higher temperature and for a greater duration than on the previous occasion, after which they are ready for service.

Although the primary object of the plant is the production of magnesite bricks, other special types, such as chrome bricks, are also manufactured.

General Store

Foresight, system, service, and expedition that govern the practice of the General Store, are not unimportant factors in securing the smooth operation of productive activities throughout the works.

System: The system ensures having on hand the right stock at the right time. Purchases of stock are handled by a special agent; a continuous audit records stock movements and definitely guards against the accumulation of "dead" or "slow-moving" lines. During the half-year ended November 30, 1934, some 11,800 different lines were handled, and 43,000 requisitions covering an issue of 172,000 separate items, were dealt with.

In addition to servicing the iron and steel works, this store services our three collieries, Messrs. Rylands Bros. (Aust.) Ltd. and B.H.P. shipping.

Service: At all times the objective is quick and efficient service. Daily distributions of stores are made by the Company's motor lorries to points as far distant as eight miles. As the delivery service is under the direct supervision of the store department, delays are reduced to a minimum.

Operation: To handle efficiently the range of materials required, suitable equipment has been installed. The lay-out has been directed with a view to rapid service and adequate care of stock. By a series of standard-steel racks that admit light throughout the multifarious articles kept in readiness, supervision is facilitated and accumulations of dust or foreign matter eliminated. Stocks are stored in these racks in trays on the unit piling system, making an audit imperative as a part of each operation in stock movement.

Shadow boarding is also utilised in the stock-keeping operation, and is an excellent means of keeping stock under constant observation.

Goods received and despatched are subject to a triple checking, each check being separate and independent of the other.



SICK AND ACCIDENT FUND

SAFEGUARDS against loss of earnings through accident or sickness have been strengthened by the B.H.P. Sick and Accident Fund, established early in 1926.

Benefits are available to contributing employees who are not on the weekly pay-roll of the steel works, and the fund is managed entirely by themselves.

Advantages of the fund are self-evident: First, the participant insures himself against total loss of income at a time when anxiety would be likely to delay his recovery and return to work. Again, his wife and family are not subjected to undue privations because of circumstances beyond their control. Lastly, from the point of view of efficiency and harmonious working, the scheme must commend itself to all who are mindful of the present, just as does the Group Assurance Scheme to those who look towards the future.

The fund is wholly maintained by the voluntary contributions of its members. These are paid fortnightly and deducted from the men's earnings by the pay office staff, whose services were readily placed at the disposal of the fund at its inception. By this means the members, whilst working, are always kept in financial membership.

Membership is entirely optional, but the pronounced increase year by year indicates a growing appreciation of the value of the fund.

In the first year the total number of members was 335, whilst for the current year the total is 2425. Last year the actual income was £5292, whilst £4471 was distributed to 525 members in sick and accident allowances, and funeral benefits of £141 were paid to dependents of nine deceased members. Since its inception, sick and accident allowances to the extent of over £21,000, and funeral benefits totalling nearly £1,000, have been paid, whilst cash rebates of approximately £3,500 have been made to the members. These figures reflect credit upon the responsible officers, and show clearly that the fund is now well established.

Funds such as this are usually hard to establish, and generally are not fully appreciated in their early years of existence, but this year the record increase of 550 new members augurs well for the future, and suggests that the fund may eventually commend itself to the whole of the employees.

A custom of the fund is to hold an annual re-union, to which representatives of the management are invited. At these gatherings a spirit of goodwill is freely expressed by both management and men, and an opportunity afforded to promote the harmony which characterises their relations throughout the works.



THE DAY'S WORK DONE.



PROVIDENT FUND

CO-OPERATIVE PROVISION OF RETIRING ALLOWANCES

AUTOMATIC provision of retiring allowances, out of a fund built up by contributions from the Company and employees, promises to solve a major problem besetting every large-scale enterprise. When a new industrial career opened in steel-production, the Company decided that it would be in the general interest if a superannuation fund on a contributory principle were established. By this means officers of long service could look forward to receiving as a right a reasonable income when the time came to retire.

After full investigation the fund was established on September 1st, 1926, and it gives every indication of fulfilling the objectives sought. From the employees' standpoint the habit of saving is formed with the least inconvenience, while the employer is afforded opportunity to help in a practical way wage and salary earners reaching the retiring age.

Each year bears its due share of accumulating liabilities, which will not mature until years later, and the united sources of revenue, accumulating at interest, provide benefits which never could be attained by individual effort. Employees' contributions are made periodically at each payment of salary, and as these contributions are adjusted to rate of salary, they are insignificant when the salary is small, and can be afforded when increases are granted.

In other words, a sliding scale has been adopted. Thus, if an officer joins at an early age, his rate of contribution is comparatively light, and continues in respect of his salary at that age until he retires. If he receives an increase at a later age, a higher rate is assessed applicable only to that portion of salary represented by the increase. Operating in this way, the average over his whole salary is not unduly heavy. In practice it has been found that some such sliding scale is more equitable than the flat rate at one time very commonly used by provident funds. Under the provident fund plan, the employee's savings are augmented by donations from the Company, and he also benefits by the higher rate of interest due to the greater opportunities for investment which a fund possesses over a private individual.

BASIS OF PENSION PAYMENT

The main object of the fund is to provide a pension at retiring age (65). If the officer has had at least 30 years' service, his anticipated pension would be 50 per cent. of his salary current at age 55. If his service is less than 30 years, then the anticipated pension would equal 1/60th of salary at age 55, multiplied by number of years' service at age 65. The maximum annual pension is £600 p.a. These pensions continue for life, but if the pensioner dies before receiving five years' full pension, payment continues to his widow or dependents until five years' pension in all has been paid as from date of retirement.

If the officer resigns of his own accord with less than 25 years' service, he receives a refund of his contributions with compound interest. If his service amounts to more than 25 years, the refund is supplemented by an appropriate share of the Company's donations. In the case of death before attaining retiring age, his widow or dependents receive a refund of the officer's contributions, together with such contributions as may have been made by the Company on his behalf, with compound interest.

It will thus be seen that, apart from the pension and other benefits accruing in respect to each year of service, the fund provides an officer with a desirable method of saving, and if, from some reason beyond his control, his service ceases before the retiring date, he has a sum available which will help him to tide over what might prove a difficult period.

The benefits of a provident fund are not usually fully appreciated until many years have passed, but the experience of our fund, gained over its first eight and a half years, has been altogether satisfactory, and augurs well for the future. The fund is applicable to the whole of the staff, which includes many of the leading hands in the operating plants. There are now 940 members on the register, and the accumulated funds amount to approximately £250,000.

Suggestions

THE Broken Hill Proprietary Company has in operation a most comprehensive suggestions scheme and a special committee meets regularly to consider ideas submitted by the company's employees.

The bonuses paid for successful suggestions have amounted to various sums, ranging from £1 to £150. In order to stimulate employees to further activity in this regard the management decided quite recently to offer a special bonus for the best suggestion received each six months.

There are four boxes, situated at different points at the Steel Works, for the receipt of suggestions, and these are regularly availed of by employees, all suggestions being treated in strict confidence.



Group Assurance

THERE is an important distinction between superannuation and life assurance. In the former, the longer the contributor lives the better is his bargain. In the case of life assurance, however, the longer the contributor lives, the better bargain it is to the life assurance company. It is just this difference which makes it so difficult to combine full life assurance benefits with superannuation in the one fund, without fixing a very high rate of contribution. Under the Company's provident fund, benefits are payable in the case of the death of an officer before reaching the retiring age, but they become substantial only after he has been contributing for a fairly lengthy period. It follows that even although an officer is a contributor to the provident fund, some form of life assurance is still desirable.

Advantage, therefore, was taken of an offer submitted by a leading life assurance society, to inaugurate a plan of group assurance. Under this plan an employee taking up life assurance is charged a premium rate below that which would be payable on an individual policy. Premiums, instead of being paid in advance, are deducted from the weekly or fortnightly pay, and further there are added advantages such as nursing services, disability benefits, and freedom from medical examination.

Membership is purely optional, and is not confined to the staff, but is open to any employee of the Company. A widespread response to this plan shows that it is much appreciated by the employees.

Apprentices

ABOUT 150 boys are employed as apprentices in various trades at the Newcastle Steel Works. Special facilities are provided so that each boy is properly trained in the trade to which he is indentured, the whole of this work being under the control of a committee of senior executive officers.

Trades: Boys are apprenticed to the following trades: Roll turning, pattern-making in wood, blacksmithing, coppersmithing, electrical fitting, electrical mechanic, metal moulding, bricklaying, carpentry and joinery, tinsmithing and sheet metal working, and mechanical engineering, which includes (1) fitting and turning, (2) fitting and machining other than turning, (3) turning and other machining.

Entrance Examination: Suitable applicants are required to sit for an examination held once a year. The subjects taken at this examination are: English, mathematics I. and II., and plane and solid geometry.

Special theoretical and practical courses are prescribed for each trade, and all apprentices are required to attend these classes at the Technical College. Class fees are refunded to apprentices provided they attend the classes regularly and pass their final examinations. A bonus of 3/- per week is paid to those apprentices whose studies, attendance, and progress at the college and workshops are satisfactory.

Prizes: Lower and higher trades courses: Cash prizes are donated annually to those apprentices who, in each year of apprenticeship, gain the highest marks at the technical college and in the workshops.

Diploma Courses: A special prize of £10 is donated to apprentices who complete their diploma course during the term of their apprenticeship. These prizes are presented annually by the manager in the presence of the committee, superintendents, and foremen of the works. Apprentices are given 12 days' leave per year.

Supervision: The master of apprentices is required to ensure that the prescribed course is followed in each case, and that the apprentice is moved from one phase of the work to another at the proper time, to keep all records as to the apprentices' training in the workshops, and to follow their studies at the Technical College.

At Whyalla and Iron Knob facilities are available for the training of indentured apprentices. At Whyalla provision is made for apprenticeship in the trades of boilermaking, carpentry, electrical, tinsmithing, fitting and turning, etc. Weekly classes are held at Whyalla Institute, where tuition by B.H.P. officers is given, and the Company allows time-off so that employees may attend. Moderate fees are charged, which are refunded from time to time by the Company as the apprentices pass their examinations. The Institute also provides classes for students in shorthand, typewriting, bookkeeping and accountancy. Special facilities are granted by the Company to enable apprentices stationed at Iron Knob, 33 miles distant, to attend classes at Whyalla.



Staff Training

A HIGH standard of personnel, and the awarding of responsible posts on a basis of proved merit and fitness, are broad objectives of the comprehensive system of staff training inaugurated by the Company some years ago.

Its ambit embraces both technical and non-technical juniors, and the scheme provides that administrative and executive positions becoming vacant be filled from within the organisation. There is substantial evidence that the scheme has proved fruitful in increasing efficiency and smooth running throughout the Company's services.

NON-TECHNICAL TRAINEES

Under the scheme, non-technical juniors, when appointed, are selected from candidates possessing either Intermediate or Leaving Certificates. On entering the Company's service they become trainees, and are immediately directed to a special course of study. They are given practical experience in as many of the divisions of the particular office to which they are attached as is possible during a probationary period of two years. After completion of satisfactory probationary service, trainees at head office and branches are exchanged with juniors from the steel works at Newcastle, and by this means all trainees are afforded an opportunity of extending their knowledge of the Company's operations.

TECHNICAL TRAINEES

The scheme provides that technical juniors entered for service at Whyalla and Iron Knob must be graduates of an Australian university. Those entered at Newcastle must be graduates or holders of provisional diplomas of an Australian university or approved technical school or college.

Whyalla and Iron Knob technical trainees undergo a two years' course of training, six months of which is spent at the steel works for general experience. Steel works technical trainees go through a training of not more than three years, during which they are employed in the various departments of the works for fixed periods.

GENERAL

Very complete records are kept of trainees, whose progress is closely followed with a view to determining from their expressed inclinations, and the ability displayed during their training, in which department of the organisation their services are likely to be of the greatest value after their training is complete.

Committees of management, consisting of the Company's senior executive officers and certain of the trainees, meet regularly at the head office and all branches, and an executive officer, who is attached to the general committee at head office, pays regular visits to all centres in the interests of the scheme.

A head office sub-committee, consisting of four of the Company's senior executive officers, meets each month for the purpose of arranging transfers and dealing with staff training matters generally. The reports and recommendations of this committee, together with progress reports of all trainees, are submitted to regular meetings of the general committee at head office, of which the Managing Director is chairman. Trainees remain under supervision and control until they have gained qualifications which are satisfactory to the general committee.

Officers' Visits Abroad

ALMOST from the very earliest days of The Broken Hill Proprietary, the Board of Directors adopted the wise policy of sending executive officers of the Company abroad in order to keep in touch with the steady advance in mining practice in other parts of the world. Since the inception of the Newcastle Steel Works this policy has been broadened in scope so that officers are always well acquainted with the latest developments in the industry.

During the past fifteen years some seventy visits abroad have been made by numerous officers of the Company, and the information gained has in all cases been applied, resulting in increasing efficiency. In addition, the Company's overseas technical consultants have visited Australia from time to time, for the purpose of studying local conditions and to confer with the Company's officers regarding plant and technical practice.



NEWCASTLE TECHNICAL COLLEGE

SCHEME FOR MODERNISING FACILITIES

INDUSTRIAL competence presupposes training and acquired skill, while advances in technique calling for more specialisation, increase the importance of technical education as an accepted responsibility of the State.

The Newcastle Technical College has expanded from small beginnings until by the end of 1934 the enrolment was 1,297, and the teaching staff 68. The College has an excellent record of achievement, and many of its former students occupy posts of exacting responsibility in industry.

A Commission of Inquiry, however, after reviewing the facilities at Newcastle, expressed the view that only an entirely new building, modernised, adequately equipped and staffed, would meet the real educational needs. Arrangements have been made, as announced by the Minister for Education, for the purchase of an additional site which would safeguard the College for the next 40 years, and so permit the steady carrying out of an orderly and effective scheme. The estimated cost is £160,000.

The Minister has proposed to the people of Newcastle that if they subscribe £20,000 in money or in kind over a period of several years, he will do his utmost to have erected a modernised Technical College within two or three years.

As an indication of the interest taken in the Technical College by the Steel Works and the allied industries in Newcastle, the Board of Directors of The Broken Hill Pty. Co. Ltd. has arranged to donate £5,000 to the College, provided the whole scheme is gone on with.

In addition, the Board of Rylands Bros. (Aust.) Ltd. is similarly making a donation of £2,000, Lysaghts Newcastle Works Ltd. £1,000, Commonwealth Steel Co. Ltd. £750, and Australian Wire Rope Works Ltd. £250.



NEWCASTLE TECHNICAL COLLEGE.

Purchase of Plant and Stores

UNDER normal conditions, £30,000 a month is spent on stores at the Newcastle Steel Works. The average consumption of lubricants, for example, is 1,700 gallons of oil and three tons of grease per month.

Blasting at Iron Knob requires about 400,000 lbs. of nitro-glycerine explosives a year. Stores are purchased for iron-ore mines, steel works, wire drawing plant, collieries, steamers, transport systems, and gold-mining. Materials range from a few ounces of borax to turbo-alternators costing thousands of pounds.

Preference is given first to Australian and second to British suppliers. Australian foundries and engineering works have received many orders for castings and forgings which for various reasons could not be conveniently supplied from the Service Departments at Newcastle. On many occasions the Company has purchased drawings from abroad with a view to Australian production of the relevant articles. By this policy machines and appliances which otherwise would not have been made in Australia have been turned out from Australian establishments.

Overseas purchases include ferro alloys required in steel-making, and also nickel. Such items are not commercially produced in Australia. The Company's demand for nickel represents 55 per cent. of Australian consumption.



Professions, Trades and Callings

SOME conception of the varied range of activities undertaken by the Company in its far-spreading ramifications may be afforded by the following list of professions, trades, and callings of employed personnel:—

Accountants	Furnacemen	Platelayers
Acetylene Welders and Burners	Furnace Workers	Plumbers
Ambulance Officers		Powder Monkeys
Assayers	Gardeners	Printers
Auditors	Geologists	
	Greasers	Quarrymen
Blacksmiths	Grooms	
Boiler Cleaners	Guards (Railway)	Riggers
Boilermakers		Roll Designers
Bookkeepers	Heat Treaters	Roll Turners
Bricklayers	Horse Drivers	Ropers and Splicers
Carpenters	Industrial Officers	Sailors
Carters		Salesmen
Chemists	Journalists	Secretaries
Clerks		Shunters
Coke Workers	Labourers	Statisticians
Colliery Workers	Lampmen	Steel Workers
Concrete Mixers	Lawyers	Stenographers
Cooks	Lead Burners	Stevedores
Construction Engineers	Librarians	Stewards
Coppersmiths	Locomotive Drivers	Storekeepers
Crane Drivers	Locomotive Firemen	Surveyors
Doctors	Machinists	Tallymen
Donkeymen	Mariners	Taxation Officers
Draftsmen	Mechanics	Telephonists
Dressers	Melters	Timekeepers
Drillers	Metallurgists	Tinsmiths
	Mill Hands	Tool Sharpeners
Electrical Engineers	Miners	Turners
Electricians	Mining Engineers	Typistes
Electric Shovel Drivers	Motor Drivers	
Engineers	Moulders	Waitresses
Enginedrivers		Watchmen
	Nurses	Weighmen
Firemen	Painters	Welders
Fitters	Patternmakers	Wharf Labourers
	Pipe Fitters	Wireless Operators

Tinplates

IN view of the large Australian consumption of tinplate, its production at the Newcastle works has for some years been regarded as a natural extension of the industry. Anticipatory provision for manufacture of the raw material has been made, and the latest developments in plant are kept under constant survey.

Several officers of the Company investigated manufacturing practice abroad, and experts have also been brought to Australia.

Where considered advisable, Australian rights for processes have been secured. The Company has also been in consultation with and purchased reports and plans from the world's leading mill designers and builders to ensure the most efficient plant and technique. The Commonwealth Government has been kept fully informed of the Company's plans.

On more than one occasion since 1918, when negotiations with leading British makers had a negative outcome, the Company's intention to lay down a tinplate plant was delayed by adverse factors, including forecasted changes in manufacturing practice having an important economic significance. The Board of Directors hopes that in the near future the prospect will be clarified and that plans may be developed on a basis of confidence that plant and manufacturing practice will represent the last word in productive efficiency.

So soon as these factors have been determined, it is proposed to proceed with the establishment of tinplate works, all the necessary provision having been made for the production of the raw material. Arrangements have been completed with leading English makers to furnish assistance in connection with the design and erection of the plant, and to give the Company the benefit of their experience and advice in the subsequent manufacture of tinplates.



THE B.H.P. REVIEW

THE first issue of "The B.H.P. Review," seven pages of foolscap folio, was published in August, 1922, under the auspices and control of the Melbourne Office Recreation Club. The issue, limited to some 50 copies, was "roneod" from a stencil, and circulation was confined to members of the Melbourne staff. The innovation, then known as "The B.H.P. Recreation Review," with its output of personalia and quizzical paragraphs, at once became popular.

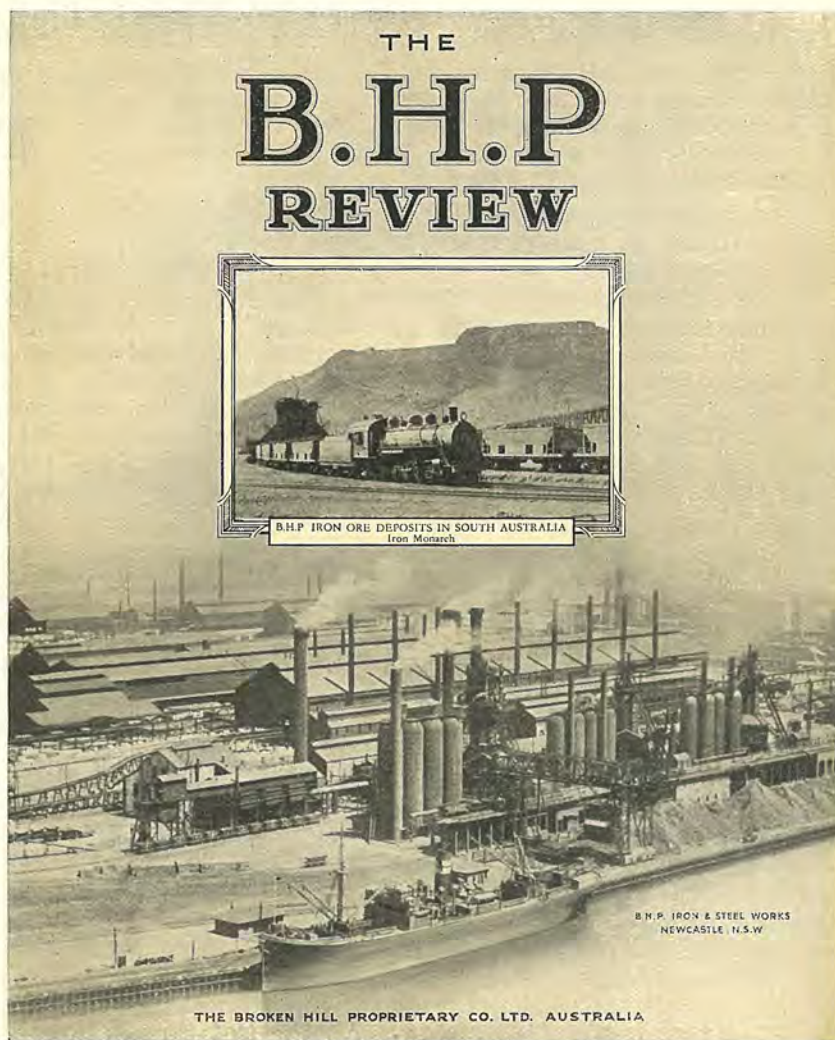
The Board of Directors, speedily recognising the value of this publication as a promoter of esprit de corps, decided to increase its scope and encourage its growth. Accordingly they placed an annual subsidy at the disposal of the "Review" Committee. At once it was decided to enlarge the circulation and to have the "Review" printed. This first printed "Review," marked Vol. 2, No. 5, left the printer's hands in May, 1924, and the issue comprised 250 copies. There were eight publications annually. The action of the directorate was greatly appreciated, and the "Review's" popularity considerably advanced.

In 1925 it was decided that the publication of the magazine was to be an integral part of the Company's operations, and that every one of the Company's employees should receive a copy. This increased the circulation into the neighbourhood of 8,000 copies. An important step was the appointment of committees at each of the Company's centres to collect material for publication and to handle the affairs of the magazine.

At first the "Review" was looked upon as the organ of the recreation clubs established at the various branches, and was not considered in any sense a technical journal. As its influence and importance grew, however, technical articles in increasing numbers found regular insertion, and the proportion of social items and articles of a general character diminished. Thus the character of the publication gradually underwent a change.

A year or so ago it was decided that the "Review" should be separated absolutely from association with the various recreation clubs, and that the personnel of the main committee of control should be a matter of annual appointment by the Managing Director. Technical articles and those dealing with B.H.P. activities, it was decided, were to form the main basis of the magazine, but the recording of personal happenings, social and sporting events, as well as a proportion of purely general articles was to be continued. The word "Recreation" was deleted from the title, and a new cover, as illustrated herewith, designed. The number of pages was increased and the publication fixed, for the present, at six issues per year. Thus "The B.H.P. Review," circulating nearly 50,000 copies annually, and grown from the stencil-printed "Recreation Review" with its output of 50 per issue, started a fresh career.

The reception accorded it in this form, both in Australia and overseas, has been much appreciated.



FACSIMILE OF COVER.

SAFETY ORGANISATION

IN all branches of its manufacturing activities SAFETY FIRST has been laid down as a B.H.P. principle. This principle is vital. The phrase is not a catch phrase.

Applied to B.H.P. operations SAFETY FIRST means that, while the company is engaged in the making of iron and steel, it is not concerned about these things to the exclusion of concern about the men taking part in the manufacturing operations. The company does not want to make iron and steel at the expense of the lives and limbs of its employees. A very great deal of effort has been put into the safeguarding of its men.

A Safety Organisation has been built up in each branch—at Newcastle, at Whyalla, and at Iron Knob. While it is realised that what suits one organisation may not suit another, the company has sought to pass on the good things in each unit for the benefit of all.

At the Newcastle Steel Works, because of its size, the Organisation is necessarily larger and more elaborate. There is a Safety Department which devotes all its time and energy to Safety, but the Safety Department is only a small part of the Safety Organisation. From the inception of the movement, the management made it distinctly understood that it did not regard the Safety Department as primarily responsible for preventing injuries to workmen, but that that responsibility was carried by the operating superintendents and foremen actually in charge of the men. The management holds the superintendent of a department responsible for the safety of the workmen under his care, just as it regards him as responsible for the quality and output of his product.

A CEASELESS CAMPAIGN

To put the prevention of personal injuries to workmen on a systematic basis, the management required each departmental head to form a Safety Committee to deal with safety matters in his department. These committees meet weekly and are usually presided over by the superintendent. In addition to him, the personnel consists of the assistant superintendent, foremen and workmen. Workmen generally rotate, the idea being that in course of time every workman in the department will have personal experience of the working of the Safety Machine. The names of the men to attend each meeting are usually posted during the week, so that any other workman may pass on through them to the committee any matter he may wish to bring under notice. These meetings are for the discussion of injuries which happen in the department, and of measures for their prevention. At the same time, stress is continually laid on the importance of bringing up unsafe situations there and then as they arise, rather than to save them for a meeting some days ahead. The meetings are regarded as furnishing opportunity for discussion of principles and practice, arising out of particular cases.

In addition to the Safety Committees in the departments, which meet on Tuesdays and Wednesdays, there is a General Safety Conference, which meets on Thursdays. This conference is presided over by an assistant of the manager and is attended by the heads of all departments on the works. The conference is about 20 strong. All the lost time injuries on the works are reported on by the superintendents responsible. Each head reports as to how the injury was received and as to steps



STANDARD SAFETY NOTICES.

Throughout the works are displayed standard enamel notices, 20-in. x 25-in., setting out definitely instructions as to guards on machinery, and giving a clear statement as to the Company's policy. Companion notices deal with the Safety Committee Organisation. These notices date from 1925.



A DEPARTMENTAL SAFETY CENTRE.

Each department has its own Safety Centre for propaganda, for keeping certain equipment used in connection with injury prevention, and for dealing with injured men.

Note:

- Ambulance Outfit.
- Graph, giving injury record.
- Posters.
- Standard Notices.
- Examples of Knots.
- Clock ("Time to be Safe" instead of Hours).
- Drinking faucet with cooled water.

taken or to be taken to prevent a recurrence. If these steps appear adequate to the chairman, the matter is so noted on the minutes. Otherwise, appropriate instructions are given.

By keeping a close weekly check on the various injuries and their cause, and maintaining a keen watch for hazards likely to cause accidents, a comprehensive practice of safety has been built up. Many of the safety principles have been embodied in handbooks, whilst others are passed on to the men verbally by the foremen.

Early in the Safety Campaign, examination of records of injuries showed that only a small proportion could be attributed to failure of materials, or want of guards. It was found that many were due to want of care or foresight on the part of the workmen, or to bad practice. It was realised that closer supervision and education of the workmen in safe practice were needed. This work was put in hand. At the same time, every endeavour was made to instal any mechanical safeguards that appeared desirable, and to make the plant "fool-proof" in a mechanical sense, if that were possible. Education in safe practice was undertaken by personal talks to groups of workmen by departmental and safety officers. Posters and leaflets were also issued.

Departmental Safety Bonuses are offered for appropriate periods without lost time injuries. This scheme has led to the distribution of quantities of articles useful in the homes and schools, and has carried the safety idea to the families of the workmen.

The following extract is taken from the instructions given by the manager to a meeting of heads of departments and foremen held in February, 1924:—

Wherever a man's work regularly takes him, there shall be provided safe means of access, ladders or stairways, safe floors, safe platforms, and safe walkways.

Such platforms, stairways and walkways shall be guarded so as to save a man from the results of slipping. Slips and trips are of frequent occurrence.

In general, a standard handrail 3 ft. 6 in. high shall be used with a 6 in. skirting piece and a middle rail. The walkways shall be, in general, of non-slip iron plate or grating.

All gears shall be enclosed.

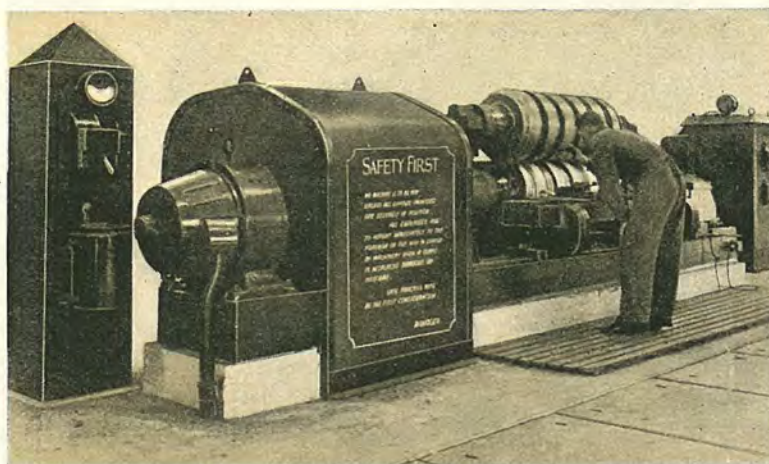
All belts shall be adequately guarded.

All moving wheels with spokes, where there is a possibility of a shear effect, if a man fell against the wheel, shall be guarded by wire mesh guards.

All platforms, guards, covers and buildings shall be kept in proper repair.

An intensive campaign to bring about the improvement of the plant in these particulars followed the meeting mentioned, and these standards have been maintained throughout the years. In these days the endeavour is always made to incorporate adequate guards and safety devices in new designs.

Unpleasant and unfortunate though the results of injuries may be, there is a lighter side to the work of preventing them. The publicity and propaganda undertaken brought to light a number of capable artists, whose posters were always clever and often amusing. Many slogans were sent in by



A ROLL-TURNING LATHE.

Note: All electrical conductors are enclosed in earthed metal cases or conduit, for protection against the possibility of electric shock. All parts which make or break the current are enclosed to prevent eye injuries from flashing.

Commutator and brush gear of motor are enclosed to prevent accidental contact and consequent electric shock.

All driving gears totally enclosed by robust sheet metal guard, with lifting lugs for handling by overhead crane.

Standard departmental machinery notice painted on gear guard, reading: "No machine is to be run unless all guards provided are securely in position. All employees are to report immediately to the foreman or the man in charge of machinery when a guard is misplaced, damaged or insecure.

"Safe Practice must be the first consideration."

employees. These slogans often revealed a ready wit and a neat turn of phrase. The following examples are taken from a big collection:—

Ask Yourself: How Accidents Happen. Then Take Care.
It's Up to Every Man to Look After Himself.
Then Again: It's Up to Every Man to Look Out for His Mates.

A Man's Work is Generally as Safe as He Wants to Make It.

A Thoughtless Step May Mean Life-long Regret.

Be Careful Always All Ways.

Safe Conditions Look Good Because They Are Good.

Better a Minute for Safety Than a Day for Repairs.

One and the Same! Safe Practice and Common Sense.

Safe Habits Save Days of Daze.

The Best Safety Device Known is a Careful Man.
If a Man's Place is in a Muddle You Have a Very Fair Index to the State of His Mind.

Safety is Not a One-Man Job. It's Everybody's Job.

Take Pains to Avoid Pains.

Beware of the Crash and Carry Business.

Do Your Share by Taking Care.

When Using the Grinding Wheel Keep Your Eyes On and Your Hands Off.

Mind How You Hook Your Sling or You May Have to Sling Your Hook.

We Care Less for Those That Are Careless.

Results of the Safety Campaign are difficult to estimate. It is, for example, impossible to say how many injuries have been prevented by guards, or what the position would have been had the effort not been expended. The consensus of opinion among the men is that the effort has been well worth while and should be continued without intermission.

The Company thanks the many thousands of persons who have assisted in its Safety Campaign. At the outset its officers received help and inspiration from the publications of Safety Councils overseas. From time to time encouragement has come from abroad from correspondents who have been reached through "The B.H.P. Review." The Company's thanks are also due to officers and employees throughout the years, who have helped by their suggestions and by effectively doing their jobs.

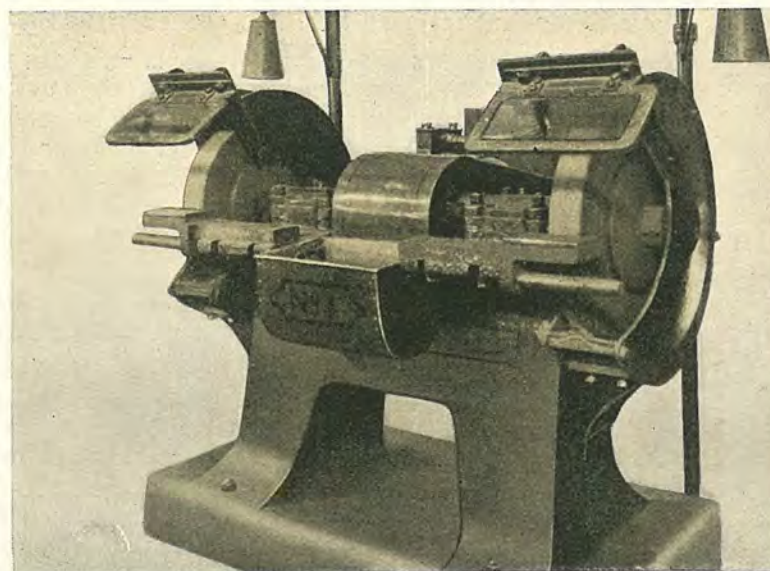
STANDARD GRINDING MACHINE WITH STANDARD GUARDS.

Heavy boiler plate guards enclosing each wheel.

Plate glass spark arrestors, which enable operators to see the job in safety.

Driving belt is totally enclosed.

Adjustable rests with fittings for dresser.





SAFETY FIRST.		
COKE OVENS DEP'T.		
BONUS PERIOD 30 DAYS.		
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 DAYS.		
LENGTH OF PRESENT RUN.	72 DAYS.	RECORD RUN. 264 DAYS.
SECTIONAL RUNS.	PRESENT RUN.	RECORD.
SIMONS SHIFT.	186	488
DOWNES SHIFT.	746	746
SOLMANS SHIFT.	332	463
BY PRODUCTS.	72	409
DAY GANG.	195	445
MECHANICS.	177	327
LEONARDS.	100	970
CRUSHER.	803	803

A DEPARTMENTAL SAFETY PROGRESS BOARD

Gives details of progress towards the next Safety Bonus. Also, lengths of current no-injury runs, and the present and past performances of the various units making up the department.

Medical and Ambulance Services

IN spite of all efforts men still suffer injuries, and it is necessary to maintain a medical and ambulance service. The Company employs a whole time fully qualified medical officer, and has a well equipped ambulance station at the works with competent ambulance officers in continuous attendance. The medical officer and four of the ambulance officers served in the Army Medical Corps during the Great War.

The Steel Works Ambulance Station is a four-roomed building near the main gate. It has specially laid hospital floors. The equipment is on the lines of the usual hospital out-patients' department, whilst provision is made for any emergency major operations. The hot water system, sterilisers, and heating system are electric.

Located at different points on the Works are 25 depots, consisting of stretchers, splints, and dressings for use in emergency. There are 30 small dressing cabinets used for immediate attention to trifling injuries. Other minor injuries and re-dressings are dealt with at the Ambulance Station. Cases of serious accidents are treated at the scene of the accident by an ambulance officer, and the Company's medical officer or an outside doctor is called in if required. When necessary, the injured man is transported to hospital by Civil Ambulance.

The Company subsidises the workmen's contributions to the Newcastle Hospital, and also to the Civil Ambulance, which has proved a great boon to the Steel Works as well as to the rest of the community. Within a few minutes a modern motor ambulance responds to a call, and the Steel Works' stretchers are standardised with the Civil Ambulance equipment.

Besides providing medical service and equipment, much has been done to impress on the workmen the importance of immediate and continuous attention to even slight injuries. "Get treatment at once" is one slogan. "Continue treatment till well" is another.

WHYALLA AND IRON KNOB

A resident qualified medical practitioner and a trained nurse are employed by the company to attend employees as required, and a surgery and ambulance room are provided at Whyalla. In addition, fully equipped ambulance rooms are located throughout the Iron Knob mines and at various points in the works.

A levy of sixpence per week is deducted from each employee's pay, which assists in providing medical attention and the necessary medicine for the employee and his family. The balance of the cost is borne by the company.

The services of the doctor and nurse are available for the residents in the district who are not B.H.P. employees.

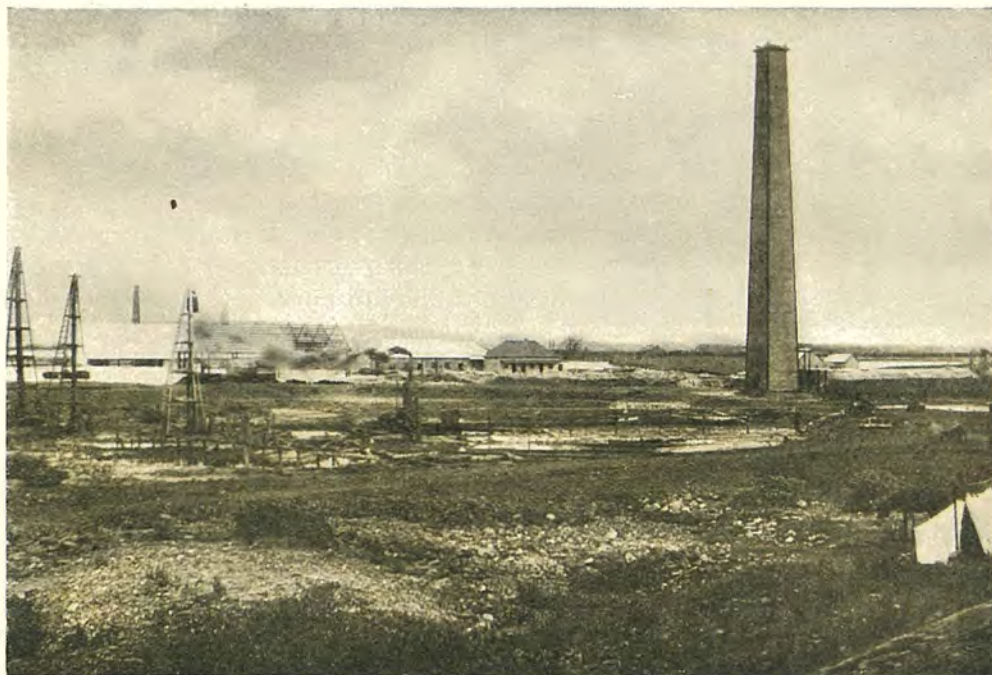


PLANT IMPROVEMENT

INFLUENCE OF ORDER AND CLEANLINESS

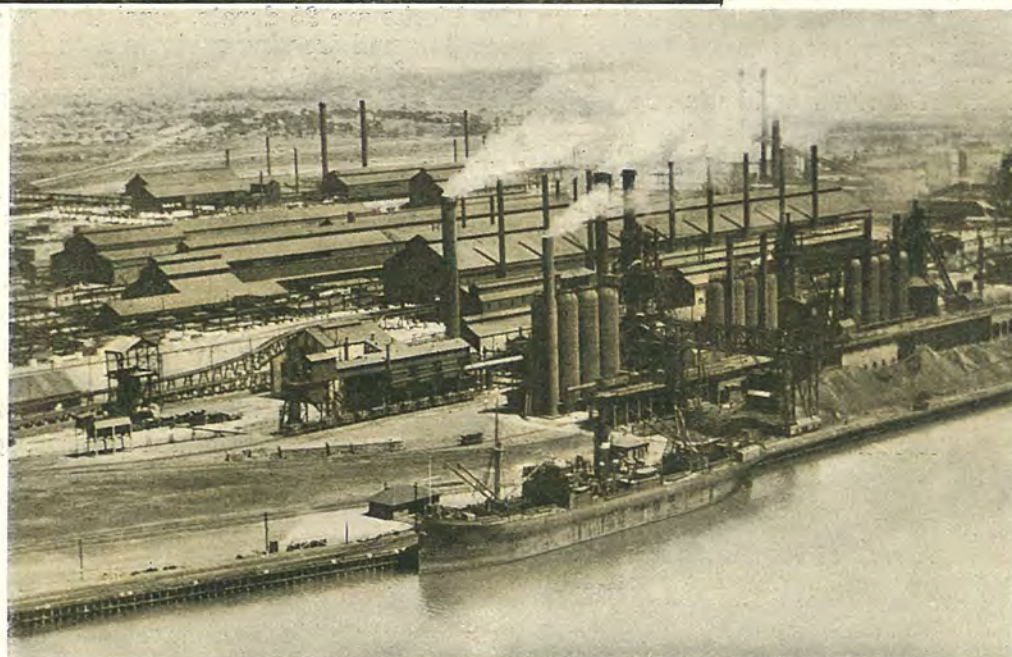
A VIGOROUS campaign waged in the interests of order and cleanliness has effected notable transformations about the Newcastle steel works. Pleasant and attractive examples exert a very definite influence upon works efficiency. For many years systematic treatment of unsightly areas and sections, more or less inescapable about works in course of development, has been undertaken.

Some striking contrasts are depicted in the accompanying illustrations. Of the present area of 340 acres, comprising the steel works, about 80 per cent. has been cleaned up, levelled and surfaced by tar spraying and blast furnace slag dressing.



The illustration at the left shows the old copper smelting works where the land was reclaimed by sand dredging from the harbour. Several derricks used for pile driving at the inception of the plant may be seen on the left of the picture.

On the right is a picture of the same area as shown above. It is covered today by a modern steel works built entirely on reclaimed ground.





Portion of old swamps being filled with refuse prior to levelling.



The same sector after levelling and treatment with ashes, tar spraying and blast furnace slag.

The railway embankment, shown above, serving the coke ovens coal crushing plant was widened at the top and a roadway put down, so that stocks of blast furnace crushed slag could be dumped therefrom. Below the embankment, previously part of the swamp, filling such as the waste from open hearth furnace refuse was placed and levelled off (top right), the operation thereafter being:—

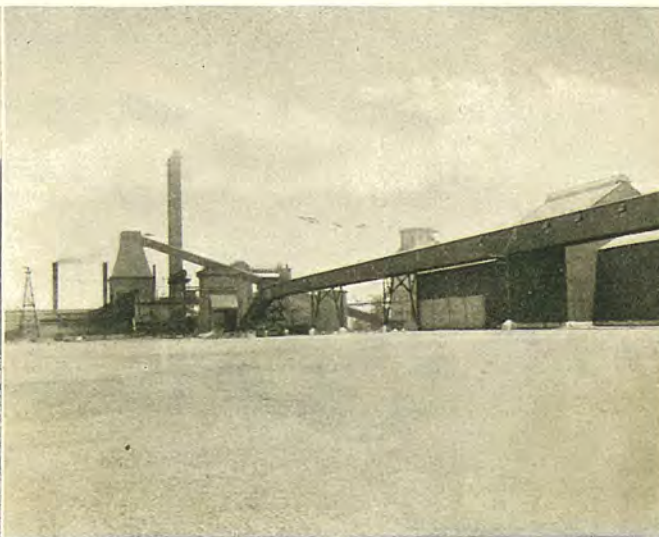
1. Spread ashes 2 inches deep, saturated with water either before or after spreading.
2. Roll.
3. Tar spray with No. 2 or No. 3 grade tar ($\frac{1}{2}$ to $\frac{3}{4}$ gallon per square yard).
4. Spread $\frac{5}{16}$ in. blast furnace slag (1 ton to 60 sq. yards).

At the foot of the embankment, slag is loaded by mechanical loader into either railway waggons or motor lorry.

A principle which has been accepted in connection with improvements is, "Nothing is placed alongside the walls of buildings, inside or out, unless arranged in a manner that will permit of orderliness and ready cleaning." When roads are to be built over the areas cleaned up, a good foundation is constructed and then, depending on the location of the road, it is decided whether "A," "B" or "C" class roads are to be laid down.



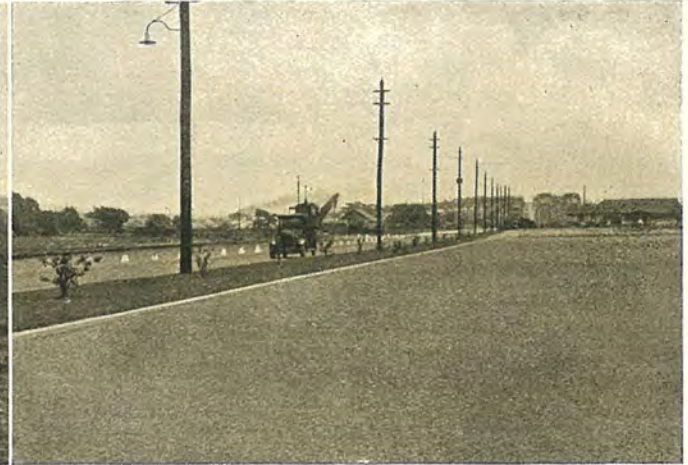
The old Semet-Solvay Coke Ovens in process of demolition.



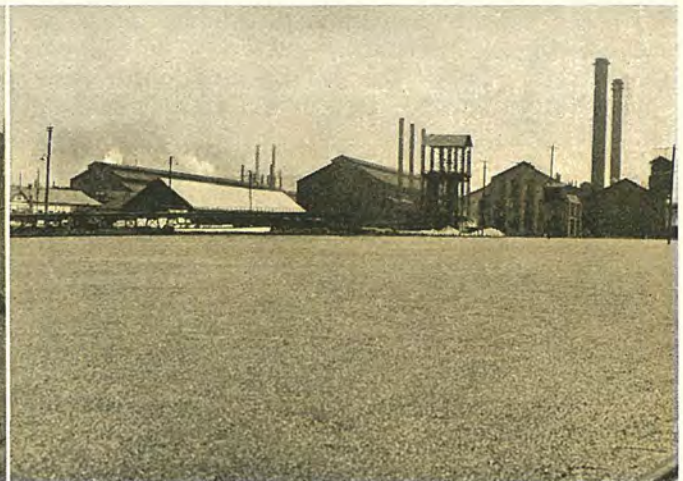
The same vicinity after survey and treatment to conform to general works levels and range.



Area looking towards Lysaghts and Rylands Works during the process of levelling up.



The finished job, a trim grass border to a smooth road.



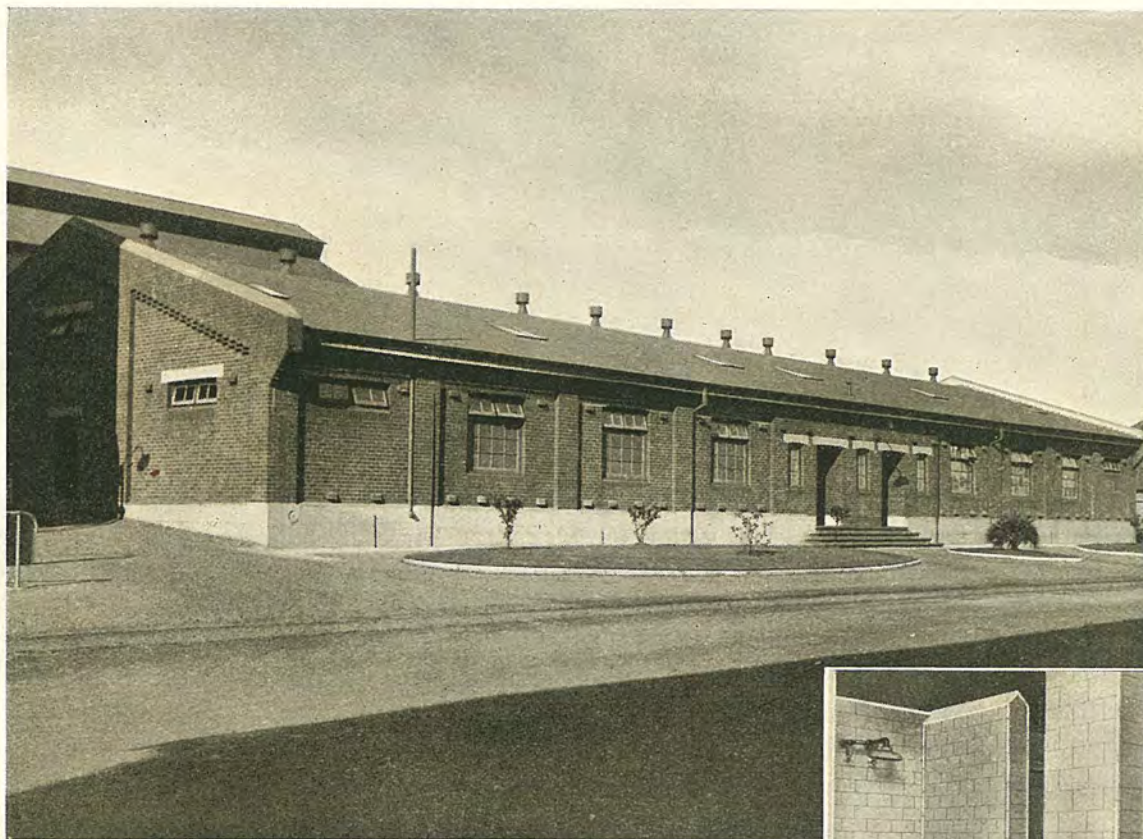
Section of plant before and after plant cleanliness campaign.



Machine shop change house, situated alongside the department.

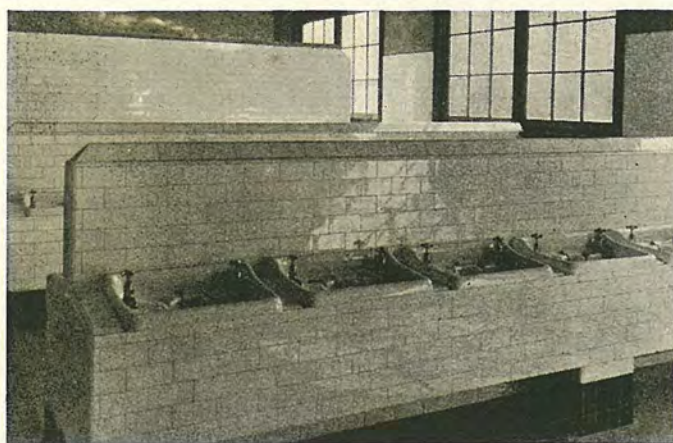
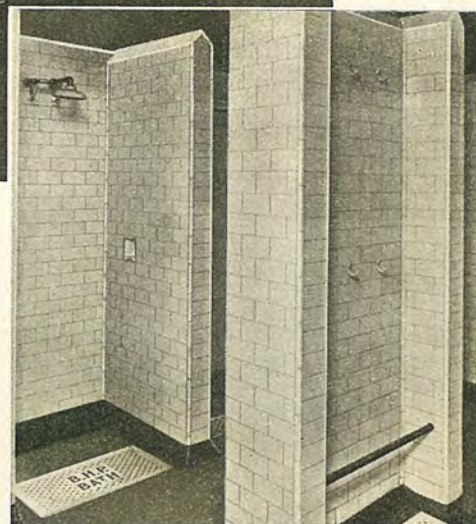


Each man is provided with a separate locker and "crib" is eaten in comfort at the tables shown.

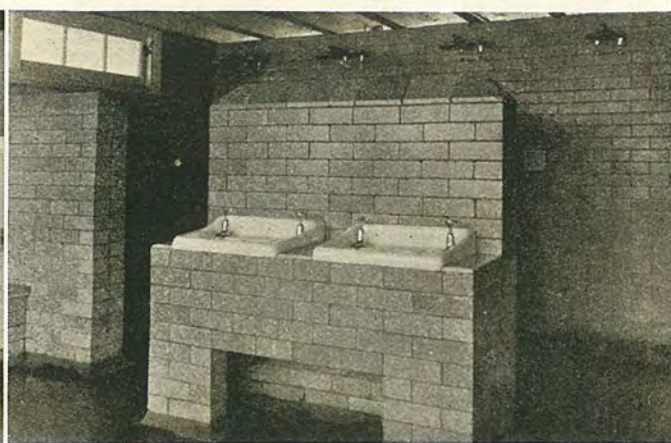


Above—Change house at the Steel Works for operatives from the large rolling mills and the fabricating shop.

At right—a specimen of the modern tiled shower baths.



A view of the Machine shop wash basins showing tile construction.



Bathroom on similar scale with taps arranged to facilitate cleaning of walls.

SHADOW BOARDS

"A PLACE FOR EVERYTHING AND EVERYTHING IN ITS PLACE"

PERHAPS the best statement of the purpose of shadow boards is given in the sub-title of this article, the boards themselves being specially fitted racks upon which tools, appliances, and spare parts in use about workshops, engine rooms, and various departments, may be readily seen and obtained. Their value in making for order, cleanliness, and system has been amply proved.

The object of the "shadow," painted in conspicuous outline on the board, is to show at a glance whether the relevant tool or part has been replaced, while a system of numbered discs identifies the workman who takes a tool and neglects to replace it.

An intensive campaign on behalf of shadow-boarding and plant cleanliness, has, after some years, produced results gratifying to all concerned. Those who were more or less sceptical became convinced advocates of the improvements which the Managing Director commenced years ago. One industrial concern after another in Australia, and others abroad, adopted the system to obtain greater plant efficiency. By its aid the supervising organisation, from the Chief down, can readily check the degree of care applied to tools and spare parts.

Experience has shown that shadow-boarding helps not only the men, but also the management, to direct attention to some article that is missing and must be traced. If departmental tools are involved, failure to trace them may be due to another department not shadow-boarded so efficiently. The

impulse of many a workman requiring tools is to go to the place where he knows there are the tools he requires. This tendency supplies further strong reason why shadow-boarding is so valuable.

It is a curious commentary upon human nature in industry, and a striking vindication of the shadow-board system, that as works reach the stage of complete equipment in this respect, the list of missing tools diminishes. A situation of heterogeneous equipment may call for some resource by departmental managers or superintendents.

There is evidence that plant cleanliness and its correlative shadow-boarding has been responsible for an appreciable increase in efficiency, whilst heightening the corporate self-respect of groups of factory and plant workers.

What is strongly impressed is the need of standardised shadow-boards as far as practicable, and standard brackets produced in early stages of the campaign are shown on this page.

Fig. 1.—A complete set of tool brackets, comprising fourteen different jaw openings, is shown at top centre, whilst below, brackets with jaw openings ranging from 2 in. to 11 in., designed to carry weights up to four cwt., are shown. With a little thought, the brackets depicted can be made to accommodate up to 95 per cent. of the tools and spares in use at the plant.

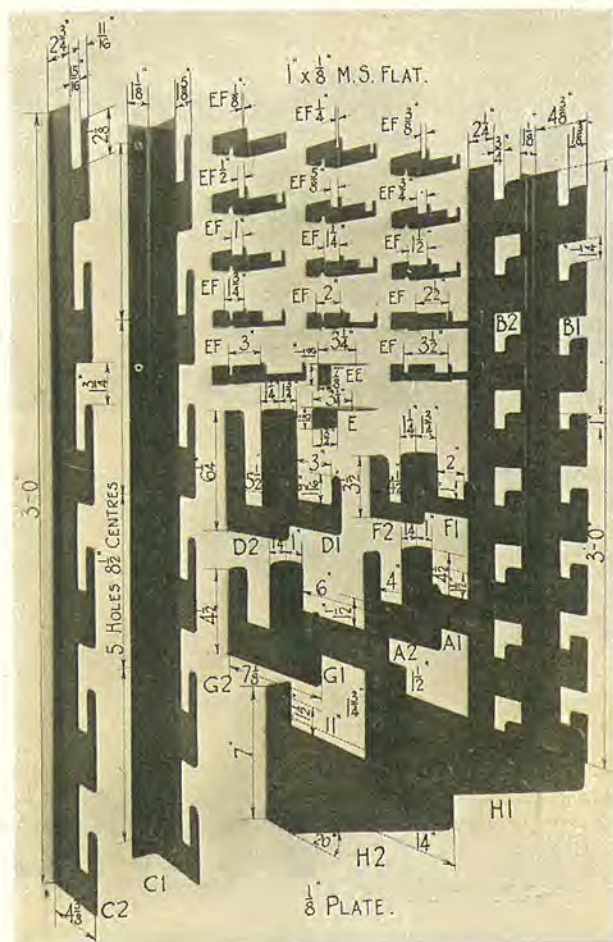


Fig. 1.

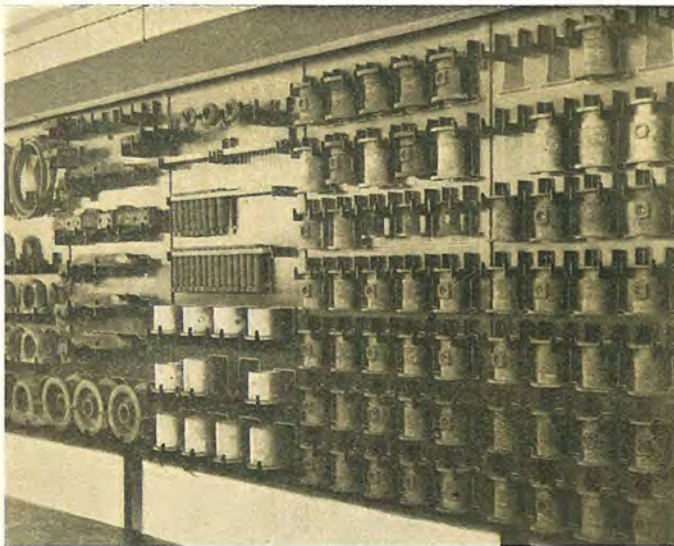


Fig. 2.



Fig. 3.

Fig. 2 shows the method of racking spare bearings, shells, etc., for the cooling beds at the 10 in. mill. Note the use of the standard brackets with standard flat section supporting the special bolts. The parallel supporting flats are set wider at the immediate right hand end so that the head will pass through when it is desired to take a bolt out.

Fig. 3 shows a shadow-board in the room used as a repair shop and office for the Steel Works Fire Brigade.

Practically every tradesman prefers to have his own tools under lock and key. Fig. 4 shows how the carpenters have used the steel-framed wire mesh covers, which can be securely locked.

In Fig. 5, the No. 1 shadow-board, now many years old, is given the foremost position in the general store, where shadow-boarding was first applied within the organisation. Under No. 1 shadow-board the chief storekeeper has utilised the wall space to construct a shadow-board of unique value, in that it racks a specimen of each firebrick and special shape brick used on the steel works.

The simplicity, openness, and ready accessibility achieved are causing the system to be widely adopted. In addition to The Broken Hill Proprietary Co. and subsidiary and allied industries, it is in use in the works of:—

The London, Midland and Scottish Railways, England; International Combustion Coy., England;

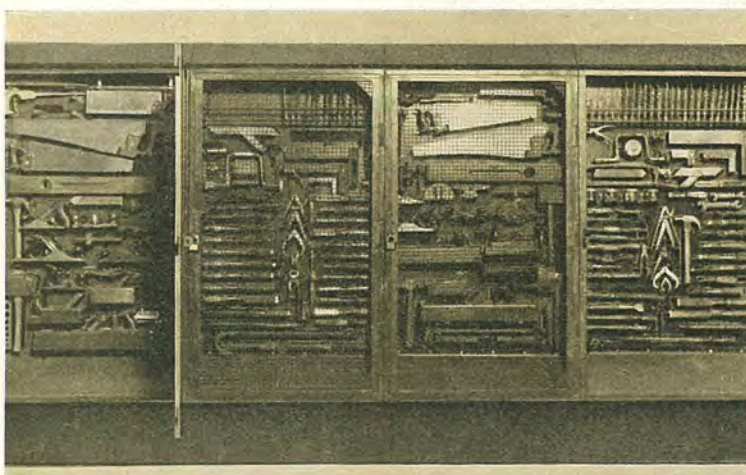


Fig. 4.

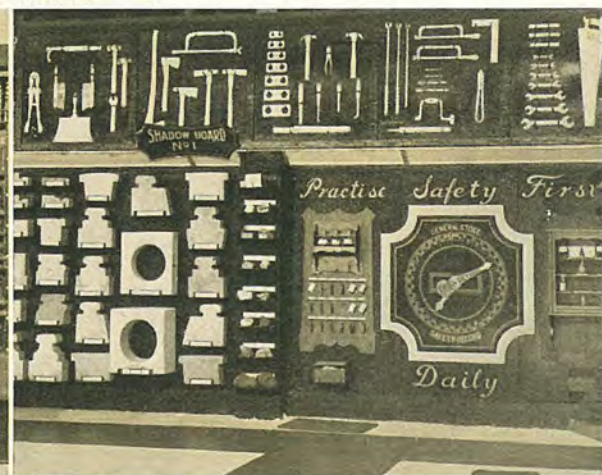


Fig. 5.



Goldsbrough Mort & Co., Adelaide; H. V. McKay Massey Harris Pty. Ltd., Melbourne; McPhersons Pty. Ltd., Melbourne; Brisbane Tramways; Sachs & Co., Brisbane; Walkers Ltd., Maryborough, Queensland.

In common with other branches of the Company's activities, Elrington Colliery has devoted considerable attention to shadow-boarding and plant cleanliness, and Fig. 6 shows how a portable oxy-acetylene outfit is arranged.

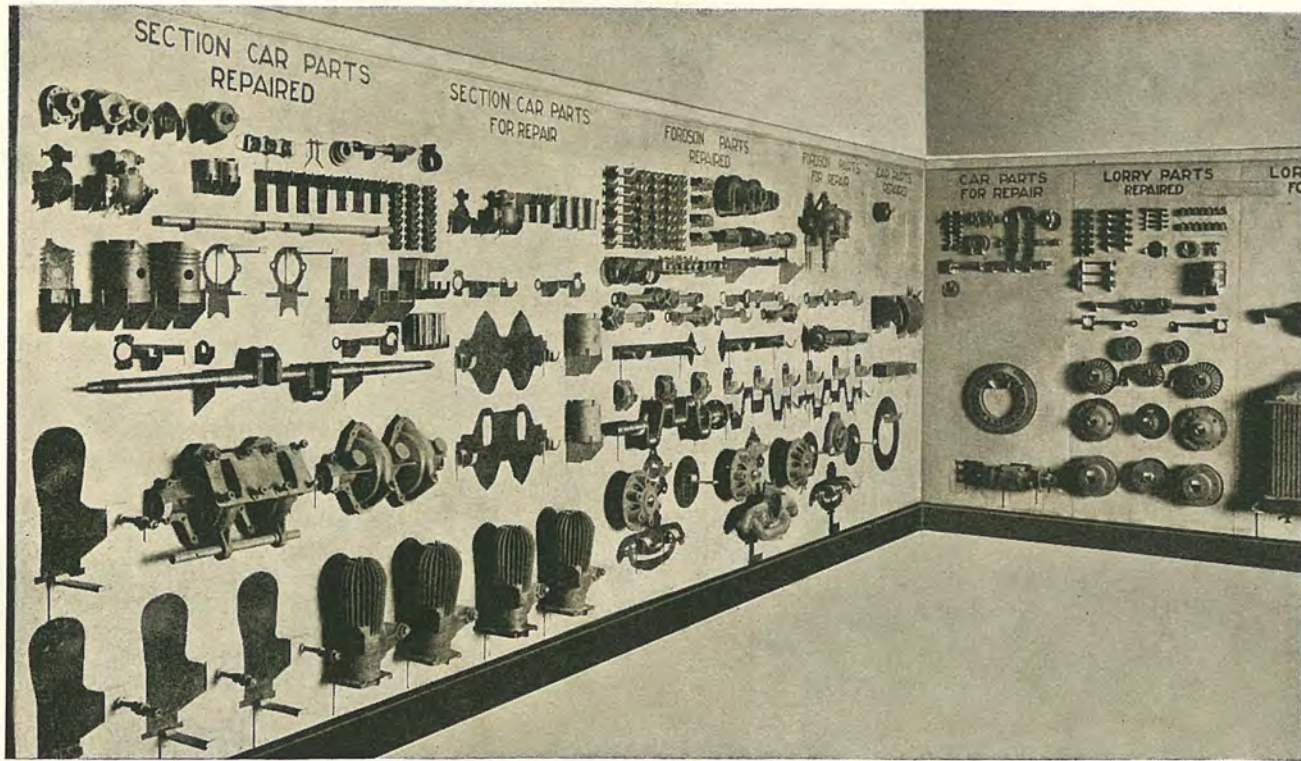
Fig. 7 shows how heavy plant spares and bulk stocks of spares, which may be placed out of doors instead of being stacked in confined areas immediately around the departments, are now arranged in orderly fashion on an open area on top of the open hearth slag dump, where quick service is rendered by means of a fast motor lorry with crane attachment, as shown. We are indebted to the Chile Exploration Company, Chuquicamata, Chile, for the idea of stocking heavy spares. The crane is so designed that heavy lifts which are placed close to the road may be lifted with equal facility to the lighter spares which are more remote. Roads parallel to that depicted are 40 ft. centres. Parts are numbered and located in defined sections so that a department may call for a particular part and expect to get quick service.



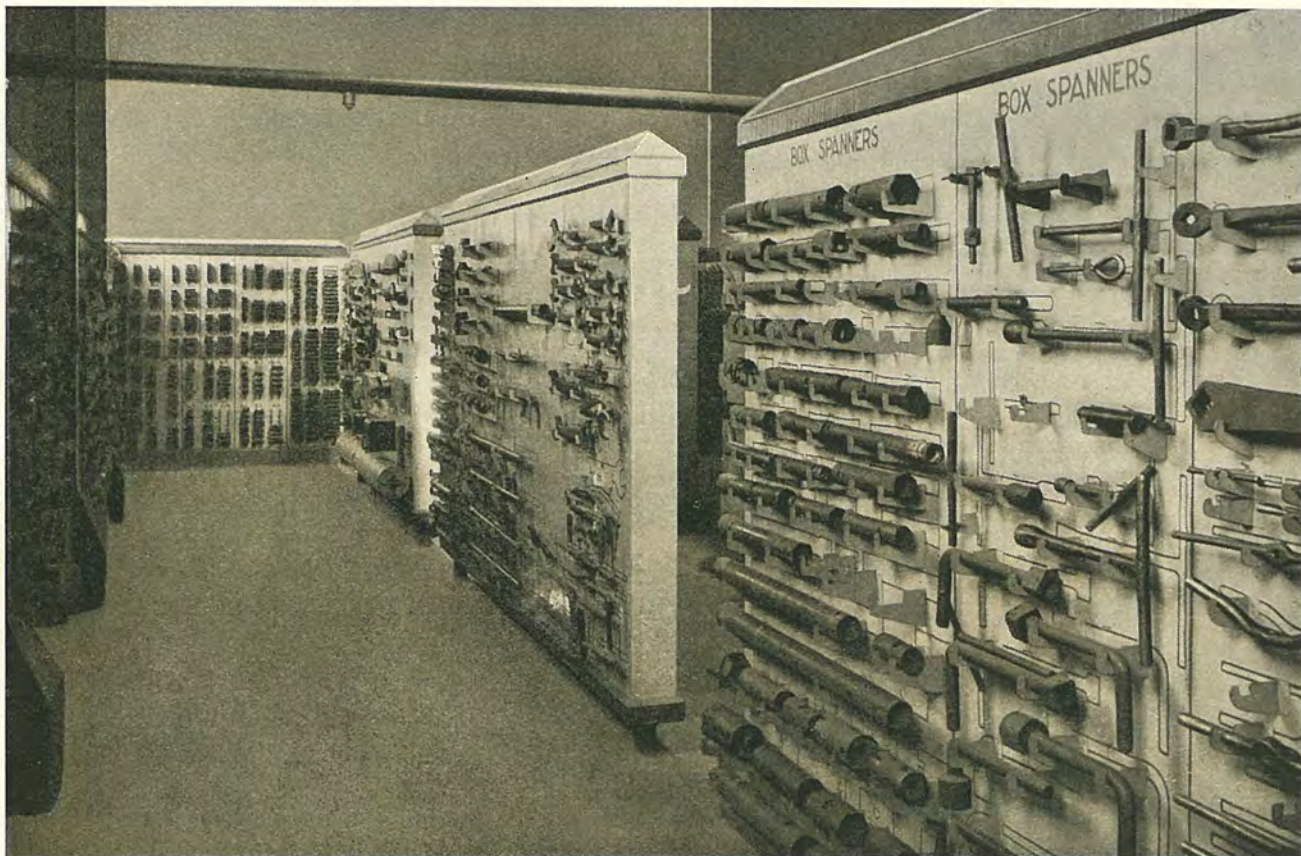
Fig. 6.



Fig. 7. STORAGE OF HEAVY SPARES, ETC., AT THE STEEL WORKS.



SHADOW BOARD FOR CAR AND TRACTOR REPAIR PARTS, WHYALLA MACHINE SHOP.



SHOWING THE SHADOW BOARD RACKING, WHYALLA MACHINE SHOP.

GOLD MINING AND PROSPECTING



HANNAN'S NORTH GOLD MINE, KALGOORLIE, W.A.

WHEN the Board of The Broken Hill Pty. Co. Ltd. decided in 1931 again to engage in the winning of non-ferrous metals, particularly gold, considerable interest was shown and a very large number of old mines and prospects were brought under its notice.

Western Australia offered sufficient promise to induce the Board to obtain a special officer, with outstanding knowledge of the Western Australian goldfields, to examine and report upon the properties submitted.

After many properties had been examined, it was decided that Hannan's North Mine justified re-opening.

The mine is situated about four miles N.W. of the Golden Mile, just outside the town limits of Kalgoorlie, and within five minutes' walk from a tram terminus. It is the northernmost mine of the field to have had an appreciable production in the past, and is situated in a belt of quartz dolerite greenstone, the rock that contains the most productive lodes of the Golden Mile.

Its development had a special interest in that the lodes in the quartz dolerite between Hannan's North and the productive mines, though worked in the past, were attracting very little attention at the time when the decision to re-open the mine was made.

The area taken up covered a length of about 3,000 feet, on a small but persistent lode channel, on which were the old mines:—Reefer's Eureka, Hannan's North, Golden Zone, Hannan's Star, and Napoleon.

Prior to 1912 this group had treated 63,182 tons ore for 61,715 ozs. gold, but were idle at that time.

Considerably later one of the large Boulder mines re-equipped the Hannan's North shaft and did some development work.

The B.H.P. Company, in 1931, decided to unwater and examine the mine. This took longer than was anticipated, as the shaft was found to be in bad repair and many of the old stopes were unfilled, so that levels and travelling ways had to be re-established. The workings extended to 685 ft. depth and the shaft to 600 ft.

It was found that the lode consisted of a quartz vein or veins from a few inches to several feet thick, with which is associated mineralised country rock, the whole making up the ore body and ranging from less than one to six or seven feet in thickness.

The lode, as a whole, is nearly vertical, and in a length of 900 feet contains three ore shoots.

During the early period of development at depth it was found that there were untested blocks of ground above the 400 ft., and their exploration has disclosed additional ore reserves.

Two faults cross the lode channel and displace it considerably. Three shoots lie in the block between these faults, and were worked by the old Hannan's North and Golden Zone mines. The Reefer's Eureka worked a fourth shoot in shallow ground beyond the northern fault. Later exploration by The B.H.P. Co. has developed this shoot between 400 ft. and 600 ft. in depth, and proved it to be of importance.

Beyond the southern fault the Star and Napoleon worked a long but narrow ore body, and this is being tested at a considerably greater depth.

When the preliminary work had been done it became evident that there was sufficient ore proved to justify a plant to treat it, but in view of the comparatively small size of the ore body, it was decided that a plant of about 1,600 long tons a month capacity, and of simple design, was all that was warranted.

The vertical altitude of the ore body, its narrow width and comparatively strong walls, combined with the fact that the ore is subdivided into three or more shoots, makes it possible to adopt "shrinkage stoping."

In commencing stoping above a drive the ore is taken out by a "leading" stope to a height of about 20 feet, and the travelling and truck way is protected by a roof of timber. Beneath this and above truck level secondary timbering is used to form ore chutes ("Chinaman chutes"). When this has been completed a second slice of the ore body is taken out and falls on the main timber. Only sufficient of the ore is withdrawn through the chutes to give the miners room to work in the stopes in safety as they stand on the broken ore close to the roof. Gradually, by successive slices, the whole of the ore up to the next level is broken, and while approximately half has been withdrawn during stoping operations to make room, the balance is stored in the stope, whence it can be safely withdrawn later as required, through the Chinaman chutes.

EXTRACTION AND TREATMENT OF ORE

Mounted rock drills driven by compressed air bore the holes which are charged with the explosives necessary to break out the ore. Hollow drill steels are used through which a stream of water to allay dust is continuously passed to the bottom of the hole during the progress of drilling.

The ore is hoisted in trucks to the brace where the trucks are tipped over a grizzly. Fines enter the mill bin, but the oversize, after washing and removal of barren rock, pass through a jaw breaker before entering the mill bin.

The ore is wet crushed in cyanide solution by stamps through a four mesh screen and passes over corduroy-covered tables. These retain the coarser particles of free gold, with a proportion of sand. The corduroy cloths are washed regularly, and the gold is recovered from the sand washed from them by grinding with mercury in a revolving barrel.

The tailing from the tables is classified to minus 150 mesh, and oversize, which is re-ground to the desired fineness in a tube mill.

Once it is sufficiently fine, the ore, after removal of excess solution, is agitated for some hours with cyanide. From the agitators, which are large vats fitted with revolving arms, the pulp passes through a series of four vats or decanters. These work on the counter current principle, so that non-auriferous solution passing in one direction meets the pulp which passes in the opposite direction. As a result, the soluble gold is gradually separated from the pulp, so that finally the gold is carried in solution out of one end of the decanting system, while the pulp, washed free of soluble gold, goes out at the other.

The barren pulp or final residue is then pumped to the residue dam, whence excess water is returned to the system.

The gold-bearing solution, after filtration, passes through a series of compartmented boxes. These compartments are filled with zinc filaments, on which the gold precipitates as a black sludge, with corresponding solution of the zinc. At monthly intervals the zinc is "cleaned up," the sludge removed and smelted to produce a bar of gold.

The chemical control required for the efficient working of this plant and the necessity for rapid determination of values for the mining section, is given by an assay office. A small repair shop and a store, together with a well-equipped steel-sharpening shop, serve the rock drills underground. The system of shadow-boarding contributes to efficiency.

Steam is generated for the main hoisting engine, but for all other purposes, including air compression, it was considered expedient to purchase electrical energy from the local power company.

When the mill began to eat into the ore reserves, the need for concurrent development was met by sinking the shaft from 600 feet to 800 feet, crosscutting, winzing, and driving on the lode. To facilitate sinking by catching up the water at the 600 feet level a three-throw electrically driven pump was installed.

Kalgoorlie Enterprise Mines Ltd.

DURING the period of active search in Western Australia, the possibilities adjacent to the larger productive Kalgoorlie mines were noted, and options were secured over a block known as the Enterprise, and some more speculative ground to the west and north of it, adjoining the Great Boulder. It was formerly worked by the Boulder No. 1 Company to a depth of about 400 feet, with no great results. Later the Enterprise Syndicate carried on mining on one shoot to 504 feet in depth.

Situated to the north of the Great Boulder, and west of the South and North Kalgurli, and in the same belt of quartz-dolerite-greenstone, it had had very little work done upon it. It was known to contain one ore body and there was some evidence that two other ore bodies had crossed the boundary from adjoining mines. It therefore was judged to be worthy of exploration.

Through the courtesy of the management of adjacent mines, it was possible to arrange to use certain of their workings as points of entry for exploratory driving, crosscutting and diamond drilling at a depth of 1500 feet below the surface.

Our earliest work consisted of driving and crosscutting to give positions from which it would be possible to drill to the points where the occurrence of ore bodies was suspected. Following the results of this drilling, driving and crosscutting became not only exploratory, but also developmental. We have at 1500 feet proved the existence of four ore bodies or shoots, and still have ground to explore. It may be stated that, with a limited number of faces and long haulages, development is necessarily slow.

Additional development at the bottom of the Enterprise Syndicate's workings (at 504 feet depth) has been sufficiently encouraging for the company to make further arrangements as to access from another shaft, and active exploration and development is being done at 750 feet and 950 feet below the surface.

At the present time the Kalgoorlie Enterprise is without a useful shaft of its own, and the policy has been followed of proving the possibilities of the mine before incurring the expense of sinking a main shaft to win the ore between the 504 feet and 1500 feet levels, and at greater depths. The ore bodies of the Kalgoorlie Enterprise differ somewhat from those of Hannan's North in that, though wider, they are not so readily recognisable.

Shearing (or fracturing) has permitted ore bearing solutions to penetrate along certain zones. These solutions bleach the greenstone, and pyrites is associated with this bleaching. Gold may be.

Other portions carry quartz, and in places the rock is silicified. The only definite guide to the occurrence of values is systematic sampling and assaying. Further, the greenstone has not suffered one simple series of fracturing. Three pre-date the introduction of auriferous solutions, and four (possibly five) are subsequent to the lode formations. This somewhat complex fracturing at times makes the following of an ore body which can only be recognised by assay somewhat difficult.

The entry of the Company into the West Australian field has thus resulted in one producing mine and in the developing towards the production stage of a second. At present, about 100 employees are engaged on the two properties.

Testing Alluvials at Wellington, N.S.W.

THE valley of the Macquarie River above the town of Wellington, N.S.W., is carved out of a very large area of Silurian rocks, which are traversed by the numerous auriferous veins, from which denudation, through long ages, has set free much gold. Its possibilities were brought under the Company's notice by various interested parties or syndicates.

Some of the first gold so set free became locked up in the lowest beds of the coal measures, of which a few small remnants remain, carrying a little embedded alluvial gold. This gold has been again released by later erosion.

The huge rivers of the Tertiary period carved great channels in which gravels associated with alluvial gold were deposited. Then these were flooded and filled by widespread basaltic lava flows which have, in many places, preserved the Tertiary channels as "deep leads."

Still the Macquarie and its tributaries deepened its valley, cutting down much of the "deep leads" and releasing more gold from the veins in its rocky floor.

Following the discovery of gold in this region by Hargraves in 1851, many important alluvial fields were worked and signs of great activity remain along the river to within a few miles of Wellington. At this point the influx of water proved too great for the diggers.

In 1899 the first of several gold dredges began work in the Macquarie. These dredges were small, and could work only where the gold-bearing "lead" was under the river. Where the "lead" passed under the high-level alluvial flats the dredges had perforce to stop.

With this information it was considered that portions of the valley held promise of becoming a dredging field for large-scale operations. Small plants were obviously futile.

The alluvial flats with which the Company is concerned range from an eighth to three-quarters

of a mile in width, beneath which the gold-bearing "lead" meanders as a comparatively narrow and crooked strip.

Intensive testing and examination have elucidated the more recent life-story of the river. Since Tertiary time it has carved a broad rockbound valley, which it then filled with gravel carrying a little gold. Then, changing its habits, it cut a narrower and deeper channel through these widespread gravels into the underlying slates and andesites, leaving some of these oldest gravels as high-level terraces, and concentrating some of their gold in the rocky gutter. Part of this is too deep for dredging, part is too poor. Next, it laid down what will be the dredgeable "lead," in places resting on rock and elsewhere on the older gravels.

Towards the completion of this stage, earth movements so flattened the grade of the stream that it could no longer transport gravel and gold. But it could and did build up flats of silt and sand to a height of fifty feet above the gravels. Last of all, the river of to-day has cut its way through the silts, so that its channel may be widely divergent from the "pay lead." It crosses the latter in places and it was in these places alone that the former small dredges were able to work.

It is interesting to reflect that some of the particles of gold in the "lead" must have been released from their parent veins in time to become included in beds formed about 250 million years ago, and that, during successive cycles of erosion, they were released from their temporary resting places in the coal measures, the "deep leads," the terrace gravels, and the older river gravels, before they were included in the "lead" from which it is hoped to remove them to the safe-keeping of the Treasury. To test the flats and determine the values and suitability of the ground for dredging, it was necessary to drill many lines of holes across the silt-filled valley to locate the pay "lead," and then bore more closely within the width of the "lead" to prove its value and yardage.

Work began in 1932 with one drill, and, later, two others were added.

DRILLING AND SHAFT SINKING

These drilling plants are of the percussion type, driven by internal combustion engines. The drill hammers a six inch pipe into the alluvium, and the gravel is removed foot by foot and panned. Thus the distribution of the gold in depth is known. The weight of gold recovered, the volume of gravel and the depth being known, the value per cubic yard is calculated. This, repeated many hundreds of times, combined with a contour survey, enables the yardage and values on which the working life of a dredge is based to be computed.

Finally, mindful of the Company's slogan "safety," a series of shafts are being sunk on selected boreholes to determine the degree of accuracy of the boring results.

These shafts require most careful sinking. They vary from 50 to 80 feet in depth, and have encountered running ground both above and below water level, while the influx of water has ranged from 3,000 to 14,000 gallons per hour. Most important of all is to maintain an exact cross-section and prevent the influx of gravel and gold from beyond the limits of the shaft which would render the results useless. To ensure accuracy, and indeed to make the sinking of the shaft possible, a steel box, without top or bottom, is forced into the ground by screwjacks.

As room becomes available a set of close-fitting timber is added below that already lining the shaft, and the forcing down of the steel box resumed. The alluvial excavated from the shaft is hoisted to the surface, where it is washed in a sluice-box fitted with a bottom designed to entangle and retain the particles of gold. Finally, the gold is collected and weighed, and with the known yardage excavated, the check against the borehole is completed.

With three drills and a shaft-sinking party a considerable number of men is employed. They live in four camps, which are moved from time to time as the work demands.



TESTING BY PERCUSSION DRILL.

MARKETING OF BY-PRODUCTS

AS the successful development of the iron and steel industry depends to a considerable extent on its ability to dispose economically of its numerous by-products, early attention was given to the question of marketing those materials produced at the Newcastle works, viz.: tar, tar oils, concentrated ammonia, sulphate of ammonia, benzol, toluol, solvent naphtha and blast furnace slag. When the Wilputte coke ovens commenced operations in 1930, the output of these by products (other than slag) was considerably extended. These ovens have a carbonising capacity of 2,430 tons of coal daily, yielding, in addition to coke, coke breeze and gas already particularised:—

28 tons sulphate of ammonia,
17,000 gallons crude tar,
5,700 gallons benzol products.

In order to treat economically the production of crude tar, a modern tar distillation plant, representing the best American and European practice, was put into operation on the 1st of October, 1934.



MODERN TYPE SPRAYER OPERATING ON A COUNTRY ROAD.

Following the visit of officers of the company to the United States of America in 1922, to study the development in the use of road tar, a leading firm of chemical engineers was engaged to make comprehensive tests of the tar produced in the old Semet Solvay by product ovens at Newcastle. Subjected to all standard tests, the tar proved to be of such excellent quality for road construction and maintenance purposes that a subsidiary company was formed, styled the B.H.P. By Products Pty. Ltd., for the purpose of developing a market for road tar and slag in Australia, and of providing the expert services which this entailed.

The tar plant at Newcastle was adapted to process the crude tar to the requirements of American and British standards. Plans for motor driven mechanical spraying machines were obtained, and these units were manufactured in Australia. The design of these spraying machines is kept thoroughly up to date, and there are now thirteen in operation. The sprayers are supplemented with tank waggons fitted with steam coils for heating the tar, so that it might be railed in bulk to any railway siding in N.S.W., and the sprayers take their supply direct from the tank waggons. Ten of these rail tank waggons, each of a capacity of 6,500 gallons, are in commission.

To facilitate the distribution and spraying of tar, local depots, complete with heating units and spraying machines, have been established at Newcastle, Sydney, Lismore (New South Wales), and Melbourne (Victoria).

In the process of distilling tar two important by-products, viz.: creosote oil and naphthalene, are recovered. Creosote oil is the base for wood preserving oils, disinfectants, deodorants, and sheep dip, and is used extensively for fluxing tars. Both creosote and naphthalene are of high value in coping with insect pests. Thus from the creosote, the company's chemists evolved B.H.P. Blow Fly Oil, which dislodges and destroys the fly maggot, prevents infection of sheep and heals those which have become affected.

The crude naphthalene from tar oil is charged into heating tanks for sublimation, the flake naphthalene being recovered from specially constructed chambers. In this form, and as moth balls, it is commonly used for household and storage purposes for protection from moths and silverfish. The Commonwealth Export Regulations require that 6 lbs. of flake naphthalene must be placed in every bale of rabbit skins packed for export.

Benzol is a high-grade motor fuel in special demand for aircraft and high-powered engines. Toluol is used in the manufacture of nitro-cellulose, lacquer, paints and the explosive, T.N.T.

(tri-nitro-toluene). Solvent naphtha has varied uses in the manufacture of rubber goods, artificial leather, wood stains and paints (as a substitute for turpentine) paint and varnish removers and special inks.

Sulphate of ammonia is recovered to the extent of 28 lbs. from every ton of coal carbonised, and has a high value as a fertiliser.

The molten slag from the blast furnace is run into large ladles, and is poured down the face of specially prepared pits, where it is allowed to cool, after which it is blasted, crushed, screened and graded to standard commercial gauges, suitable as aggregate for concrete and for use in all forms of road construction, either with or without tar or bitumen. Under normal working conditions, the output of crushed slag is approximately 6,000 tons per month.

From the inception of the steel works, iron blast furnace slag has been used for every concrete structure at Newcastle Iron and Steel Works and subsidiary industries, with abundant success.

It is interesting to note that 28,000 cubic yards were used in the foundations for the Wilputte coke ovens, concrete storage bins, etc. Practical and laboratory tests show that, as an aggregate for concrete, iron blast furnace slag gives more than the compressive strength required under standard specifications. During the past 5 years upwards of 40,000 tons have been used by the N.S.W. Public Works department in the construction of large concrete storm water channels, bridges and sewerage scheme in the Newcastle district alone. The Main Roads dept. of N.S.W., and leading municipal bodies, have for many years regularly used large quantities in all types of road construction.

Slag has also been used extensively by the Hunter District Water Supply and Sewerage Board for reservoir construction, and it is interesting to note that the shafts and tunnels carrying the Chichester Water Mains to Newcastle under the Hunter River are built of concrete in which blast furnace slag is the aggregate.

In order to meet the demand for aggregate mixed with tar for road construction and maintenance, a modern tar-slag-mixing plant was built at Newcastle in 1926. The crushed slag is conveyed by belts to revolving driers, and mechanically mixed with hot tar in accordance with standard specifications. Delivery is effected by means of motor lorries within a 30-mile radius of Newcastle, thus enabling it to be spread or dragged on to the roads while the material is in a hot condition. A considerable mileage of roads so constructed is satisfactorily carrying very heavy traffic. The plant has an output of 120 tons per 8 hours.

In Tasmania, road work offers a market for the waste material from the Melrose Quarry, in the form of fine limestone, mixed with the clay from the overburden.



BERESFORD SCHOOL HILL BETWEEN NEWCASTLE AND MAITLAND, N.S.W.

Ten miles of this road were constructed in 1926-7 using B.H.P. slag, penetrated and sealed with B.H.P. tar. Carrying an average of 1,100 vehicles a day, the road has had no further treatment and is still in excellent condition.



THE COLLIERIES

MODERN PLANT AND EFFICIENT TECHNIQUE

A policy of ownership of coal mines or the leasing of coal-bearing areas as a source of fuel supply for the Steel Works was adopted by the Company over a decade ago. In addition to the actual development in 1925 of John Darling Colliery, near Belmont, and Elrington Colliery near Cessnock, N.S.W., the Company has in the past few years acquired several other collieries within easy access at Newcastle, viz., Burwood, Lambton, and Redhead, containing extensive deposits of high-grade coal. A description of productive activities follows:

Modern plant and equipment, increasing usage of electric power, improved safety devices and efficient ventilation make for the well-being and comfort of the mine workers.

At the Lambton Colliery a virgin seam is about to be worked on a basis of complete mechanisation so far as winning coal is concerned. Ingenious electric machines will undercut the coal, bore the shot holes, and finally load the broken coal into skips for haulage by electric locomotives to the shaft.

Elrington Colliery

SITUATED six miles from Cessnock, and by rail 36 miles from Newcastle, Elrington Colliery gives an early impression of modernity. Surface appointments in brick and steel housing are typical of the whole equipment, including the underground arrangements.

The area of this holding is 3,900 acres, including 1,520 acres freehold, and is well served by railway and road facilities, including a three-mile railway owned by the Company. The Colliery is owned by B.H.P. Collieries Pty. Ltd., in which Hebburn Ltd. is a shareholder.

Active sinking at Elrington was begun early in 1925, but owing to prolonged industrial disputes, coal production did not start till late in 1930. Two shafts, each of 18 feet diameter, and lined with concrete throughout, had pierced the top Greta seam at a depth of 1,200 feet. The seam, including bands, is 23 feet thick, but at the present time only the bottom portion, up to a thickness of 12 feet, is being worked. The first working is to a height of seven feet, and the remaining five feet is taken as "tops."

No. 1 shaft, which is the upcast, and which will ultimately be the main hoisting shaft, has not yet been fitted up for coal drawing. No. 2 shaft, by which the whole of the output is being raised, is



GENERAL VIEW OF No. 2 SHAFT TOP, ELRINGTON COLLIERY.



MAIN HAULAGE ROADS

(Elrington Colliery)

The illustration shows two storage-battery-operated locomotives and three-ton steel skips on the 3ft. 6in. gauge track.

provided with an electric winding engine, with Ward Leonard control operated automatically from the bottom and the top.

After a smooth and swift descent to a depth of 1,200 ft., the visitor begins his tramp along the underground roadways. His lamp gleams on the whiteness of lime dust, with which the workings are thoroughly dusted throughout to obviate explosion and ignition of coal dust. This dusting also improves the light in the mine. The main tracks are laid with 60 lb. rails. In working places 30 lb. rails are used, and to facilitate the loading of the skip at the face, extension rails, free to slide on the ordinary rails, are employed.

Bord-and-pillar is the system used in working. Both bords and cut-throughs are six yards wide, with pillars 29 yards by 40 yards. The workings are laid out in panels, to enable quick and efficient sealing off, if necessary, and the necessary supplies of bricks, sand and water, are kept in readiness at the entrance to each panel.

The underground haulage is done by 8-ton battery-operated electric locomotives. Five locomotives and seven batteries take care of the whole of the output from the face to the pit bottom. The batteries are charged, each shift, in well-lighted, modern sub-stations underground.

The skips are all of steel construction, with a capacity of three tons of coal, and operate on a track gauge of 3 ft. 6 in. They have semi-automatic couplers which act as buffers, and their ends are splayed, so that a man may stand between them when coupled, without being "squeezed." Trains of from 14 to 20 of these loaded skips are made up near the coal face, and hauled by the locomotives to No. 2 shaft. On reaching the surface, the loaded skips gravitate from the shaft to a tumbler of the semi-rotary type. This transfers the coal to a conveyor, while from the tumbler a creeper elevates the empty skips to a point from which they gravitate back to the shaft. As the coal travels over the conveyor, which is made up of wire screen cloths of 1½ in. mesh, the small coal falls through and is conveyed to the waggons. The large coal is delivered on to a rubber belt conveyor, where it is cleaned and delivered into 12-ton railway waggons. Trains are made up in the marshalling yards for despatch with the coal to the Steel Works.

Motive power and lighting throughout are of electricity supplied by the Hebburn Colliery. All underground employees are provided with electric cap type safety lamps; examining officials carry flame type safety lamps. Compressed air pumps are used in the workings. These deliver the water to a sump at No. 2 shaft bottom, where it is picked up by a 12-stage electrically operated turbo pump running at 3,000 r.p.m. and delivering 100 gallons a minute against a head of 1,200 feet. Ventilation is produced by an electrically-driven fan, capable of delivering 400,000 cubic feet of air a minute, with a water gauge pressure of 6½ inches.

Elrington's present output is 1,100 tons of coal a day. Fully equipped, the colliery will produce 3,000 tons a shift. The number of employees, including staff officers, is 300.



John Darling Colliery

MODERN method also marks the equipment of the John Darling Colliery, and the provision for safety and comfort of the employees. It applies even to the brick stable and the 10-acre exercise paddock for horses used underground, affording a sharp contrast on humane grounds with the discredited past of coal-mining.



JOHN DARLING COLLIERY, N.S.W.

The horses are brought to the surface every day, and, apart from considerations of kindness, are found to keep condition and to work more satisfactorily on this account.

This colliery is situated 12 miles south of Newcastle. The area of the holding is 10,000 acres, of which 4,320 acres are under the Pacific. The village of Belmont, on the shore of Lake Macquarie, is a mile south of the colliery. The area extends for $9\frac{1}{2}$ miles north and south from the shafts.

The sinking of two shafts, each of 22 feet diameter, was begun in 1925. With the exception of 20 feet at the surface, the lining of the shafts is of concrete. In sinking, the shafts passed through strata of natures varying from soft coal and shale to very hard conglomerate, which in one bed was 150 ft. thick. The Victoria Tunnel seam was bottomed on June 10, 1927, at a depth of 650 ft., and of a thickness of 10 ft. 3 in., of which 5 ft. 9 in.

is workable. The Borehole seam was bottomed on October 21, 1927, at a depth of 870 ft., with a thickness of 6 ft. $8\frac{1}{2}$ in., and a working section of 5 ft. 8 in. In all eight seams were proved, of a total thickness of 130 ft.

The surface buildings and colliery headgear were fabricated at the Newcastle Steel Works. The headgears at both shafts rise to a height of 90 feet to the centres of the pulley-wheels. The wheels are 16 feet in diameter at the main shaft, and 18 feet diameter at the air shaft. The downcast shaft is used for the Victoria seam, and the upcast shaft for the Borehole seam.

Descent to, and a tramp through the workings reveal the development of the plan of safe and sane working conditions. The ventilation fan is designed for 600,000 feet of air a minute, at 4 inch water gauge. The mine is limestone-dusted throughout. The six-stage centrifugal pump has a capacity of 25,000 gals. an hour at a head of 650 feet.

With the development of the seams, the output was gradually increased, until it has reached over 2,000 tons daily. The length of headings opened is 20 miles. The visitor sees comparatively little of the development. He takes the mere impressions of the dryness, coolness, and security, the measured passing of laden skips converging in ordered sequence to the shaft. The haulage plant is designed for a working load of 17 tons, with electric sets replacing steam-winders, and double-deck cages carrying three skips on each deck.

The skips, after being weighed, run on to a double-strand creeper chain, fitted with tilting spurs, and are elevated to a point where they gravitate to any of four mechanically operated tipplers. Shaking screens separate the large and the small coal. The large coal is delivered on to two picking belts, each 4 ft. 6 in. wide, and 80 ft. long. The clean coal passes down to a chute loading into waggons for despatch to the Steel Works.

The boiler plant comprises two B. & W. boilers, with a grate area of 144 square feet, designed for burning refuse from the mine. Electric power is generated at the colliery, the total capacity being 1,355 k.v.a. Power is transmitted from the John Darling to the Burwood Colliery, six miles off, and to the Lambton Colliery, at a distance of three miles. Employment represents 535 men.



BURWOOD COLLIERY, N.S.W.

Burwood Colliery

BURWOOD Colliery was taken over from the Scottish Australian Mining Coy. on September 21, 1932. The area of the property is 3,360 acres, of which 1,462 acres underlie the Pacific Ocean. The plant is rapidly being converted from steam to electricity.

The main shaft goes down 600 feet on the Borehole seam, which is the only seam yet worked. The thickness varies from 5 ft. 6 in. to 7 ft., including the penny bands. The Victoria Tunnel seam is found at a depth of 320 feet, with a thickness of 7 ft. 5 in.

The units converted to electricity, so far, are the fan engines, air compressor, pumps, and screening appliances. With the conversion of the steam-driven haulage, the winding engines will be the only steam unit. Until recently, coal getting has been worked by hand, but coal cutting machines of the chain type are to replace the older method.

The pumping plant has been converted to electricity. One pump, delivering water through an 8 inch borehole, has a capacity of 40,000 gallons an hour. The pump to deliver the water at the main shaft, has a capacity of 25,000 gallons an hour. The motor is of 150 h.p. The Walker ventilating fan, now with an electric drive, produces 190,000 cubic feet of air a minute, with a water gauge of three inches. The capacity of the motor is 180 h.p. The fan speed is regulated by hydraulic coupling, the first of the type in Australia. This device, regulated by a hand-operated wheel, represents an economy in electric power.

The screening plant has been remodelled. It is operated by motors controlled from a central point, with the various units synchronised, to suit output. The coal is discharged from the skips on a shaking screen for separation of the large coal from the small. The large coal is shaken on to two travelling belts, 80 feet long by 4 ft. 6 in.

As it travels on the belts, rubbish is picked off by hand. The clean coal goes on by conveyor to the chute for delivery to the coal waggons. The small coal is received on the scraper conveyor below the screen, which removes the fine coal or "duff." Under Burwood's system all coal is treated as "large" for cleaning purposes; the screened, small coal is mixed again on the scraper conveyor, which delivers to the waggons the unscreened coal. Thus the difficulty in cleaning unscreened coal, owing to the mixture of large and small on the picking belts, is overcome.

The underground haulage system is all of endless ropes, with a 10 mile total length. A storage battery locomotive of seven tons is used for transport. The method of working is bord and pillar. Under the ocean bords are six yards and pillars eight yards wide. The output of coal is 1,100 tons a day. Power supplied from John Darling Colliery, with a voltage of 6,600, is broken down at Burwood sub-station to 2,200 volts for the fan, and to 415 for the other surface appliances. It is transmitted down the main shaft at 2,200 volts for pumping and hauling. At Burwood there are 390 employees.



Lambton Colliery and Its Mechanisation

LAMBTON COLLIERY, another of the properties of The Broken Hill Proprietary Co. Ltd., is situated some nine miles south of Newcastle. Connection with the Company's Steel Works is by the New Redhead Estates Railway to Adamstown, a distance of six miles, thence by the Government line a further distance of three miles. On the north the area is bounded by the Burwood Colliery holding, and on the south by the John Darling Colliery, both of which are the property of the company. The area of the estate is 5,400 acres, underlying which are two seams of coal—the Victoria Tunnel or Burwood seam, which is found at a depth of 200 feet in the main shaft, and the Borehole seam at a depth of 430 feet from the surface. The Victoria Tunnel seam is virgin, and about to be developed on a basis of complete mechanisation, so far as coal-getting is concerned.



LAMBTON COLLIERY.

The actual mining of coal in the Newcastle district from its inception some 70 years ago, presents many interesting features. In the earlier days the preparation of the coal by the miner was a skilled undertaking acquired by constant practice. Thus the miner undercut the seam to a specified depth and cut or nicked the ribs before blasting was permitted. In many instances the use of explosives was prohibited, recourse being had to wedges for breaking down the coal.

Specially selected officials exercised careful supervision over this department, and any departure from established practice was generally followed by serious results to the offenders.

RADICAL CHANGES IN MINING PRACTICE

In those days the miner was paid on the production of lump coal, which naturally resulted in the production of a minimum of smalls. Many amendments have been made in the law as applied to the weighing of coal, and to-day the miner is paid for the total contents of the skip before it is tipped on to the screening appliances. Regardless of the quantity of lump coal, payment is made for the total contents of the skip at a common rate, the result being a largely increased production of smalls and a corresponding decrease in lump. In some cases the yield of smalls is 50%. It can be safely stated that in the northern district of New South Wales the preparation of coal by the miner is a lost art. The process to-day, apart from machine mining, is nothing more or less than quarrying or blasting off the solid. With the introduction of the coal cutting machine a much improved article was produced with a high percentage of lump coal.

In the mechanisation of Lambton Colliery, electrical power will be used throughout. The power plant is situated at the company's John Darling Colliery, some three miles south of Lambton, and is transmitted at a pressure of 6,600 volts to a sub-station at the latter, where it is transformed to 2,200 volts for transmission underground. At a sub-station adjacent to the pit bottom the pressure is further reduced to 415 volts, which is the voltage of the various mechanisation units. Junction boxes to control the trailing cables will be used, one box being sufficient for two machines.

The complete mechanisation of Lambton Colliery will include the following cycle of operations:—

- | | |
|---|------------------------------|
| 1st—Undercutting of the coal. | 3rd—Loading coal into skips. |
| 2nd—Boring of shot holes and shooting the coal. | 4th—Loco haulage. |

FIRST PHASE: The coal cutter to be installed is of the Arcwall type, electrically operated. It is known as the track type. The machine is worked from the track and can be arranged to cut anywhere

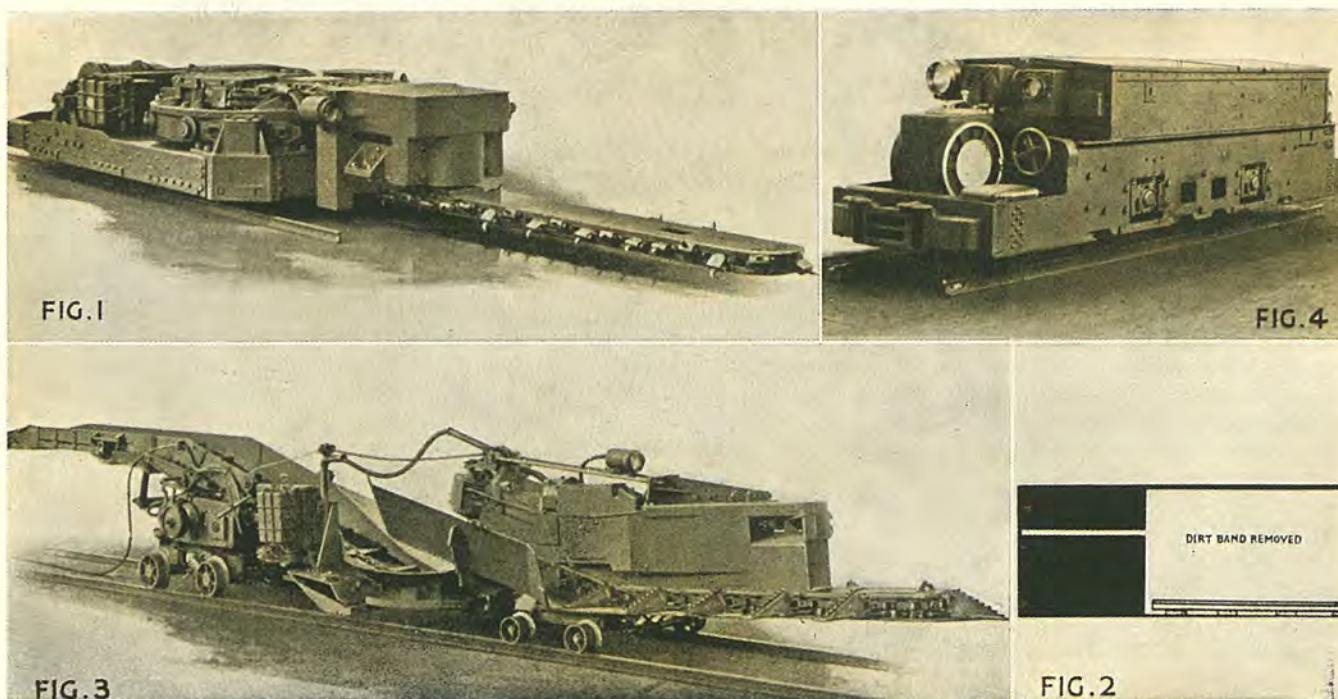
in the coal seam between floor and roof. The range, however, of the Lambton Colliery machines will be 48½ in. It is proposed to cut at a height of approximately 34 inches from the floor. A great advantage in the case of this class of machine is the speed with which it can be transported from one working place to another, and, due to the fact that it can go instantly to work as soon as it comes into a working place, can cut approximately twice as many places as the ordinary bottom cutter in a given period of time; consequently fewer machines are required for the same output.

As the machine never leaves the track, a more rugged construction is permissible, which ensures greater dependability. The weight of the machine is eight tons. The overall width is 70½ in., length without cutter bar 13 ft. 1 in., gauge of track 42 in., wheel base 36 in. The weight of rails will be 45 lbs. per yard on main entries, and 30 lbs. in the working bords. The machine is self-propelled, has a fast speed for tramming and a slow speed for cutting. The h.p. of the cutting motor is 50, and that for tramming 15, at 415 volts 3 phase 50 cycles. The depth of the cut will be eight feet, and it is estimated that the cut will produce 40 tons of coal.

Fig. 1 is an illustration of the machine. Fig. 2 is an elevation showing the completed cut.

SECOND PHASE: The drilling of all shot holes will be performed by an electrically operated machine, which will complete an eight foot hole in about two minutes.

THIRD PHASE: The introduction of coal loading machines at Lambton Colliery represents a new departure in New South Wales coal mining practice. Hitherto all coal loading was performed by hand. The mechanical loader displaces the old hand shovel, which is a somewhat laborious part of the miner's work. The loader is of the track type and is composed of two units—the front or gathering conveyor and the rear or discharge conveyor—and under favourable conditions will load about 300 tons per day. The rear conveyor receives the coal from the gathering conveyor, elevates and discharges it into the mine cars at the end of the boom. The machine is operated by two motors, each of 15 h.p. Fig. 3 illustrates the type of loader to be installed at Lambton Colliery.



FOURTH PHASE: Usually horses are used underground for transport purposes, but at Lambton Colliery, where the skips will carry 2½ tons of coal, traction will be by storage battery locomotives, fitted with two motors, the combined horse-power being 33. The cells, which number 80, are of the Edison C.10 type, voltage 80. The weight of the outfit is 15,000 lbs. Gauge of track, 42 in. Fig. 4 shows the loco. which will be installed.

GENERAL: Following the mechanisation of coal getting operations, future plans provide for the complete electrification of the whole of the plant at the colliery.

Rylands Brothers (Australia) Limited

NEWCASTLE, N.S.W.

IN 1889 the Austral Nail Co. Pty. Limited was established at South Melbourne by Mr. James MacDougall, and production was confined to wire nails until 1905, when the manufacture of barbed wire was commenced.

A plant for the drawing of the Company's requirements of nail wire was installed in 1911, supplies of wire rods being imported from overseas. War conditions in 1914, and Australia's needs, justified an extension of the plant, the output then reaching 300 tons a week. Throughout the war period, Eastern Australia drew practically the whole of its supply of fence and nail wire from these works. In 1918, The Broken Hill Pty. Co. Ltd. installed a rod mill, which produced from September of that year the whole of the Austral Nail Company's requirements. To eliminate the cost of transporting the raw material, a modern wire mill was established in close proximity to the steel works at Newcastle. It was designed to cope with the general requirements of the Commonwealth, production commencing on 25th September, 1919.

In 1921, Rylands Brothers of Warrington, England, decided to establish works in Australia for the manufacture of netting and other wire products, but a merger with the Austral Nail Company was arranged under the present title of Rylands Brothers (Australia) Limited. In 1925, the Broken Hill Pty. Co. Ltd. took over the whole interests of Rylands Brothers (Australia) Ltd.

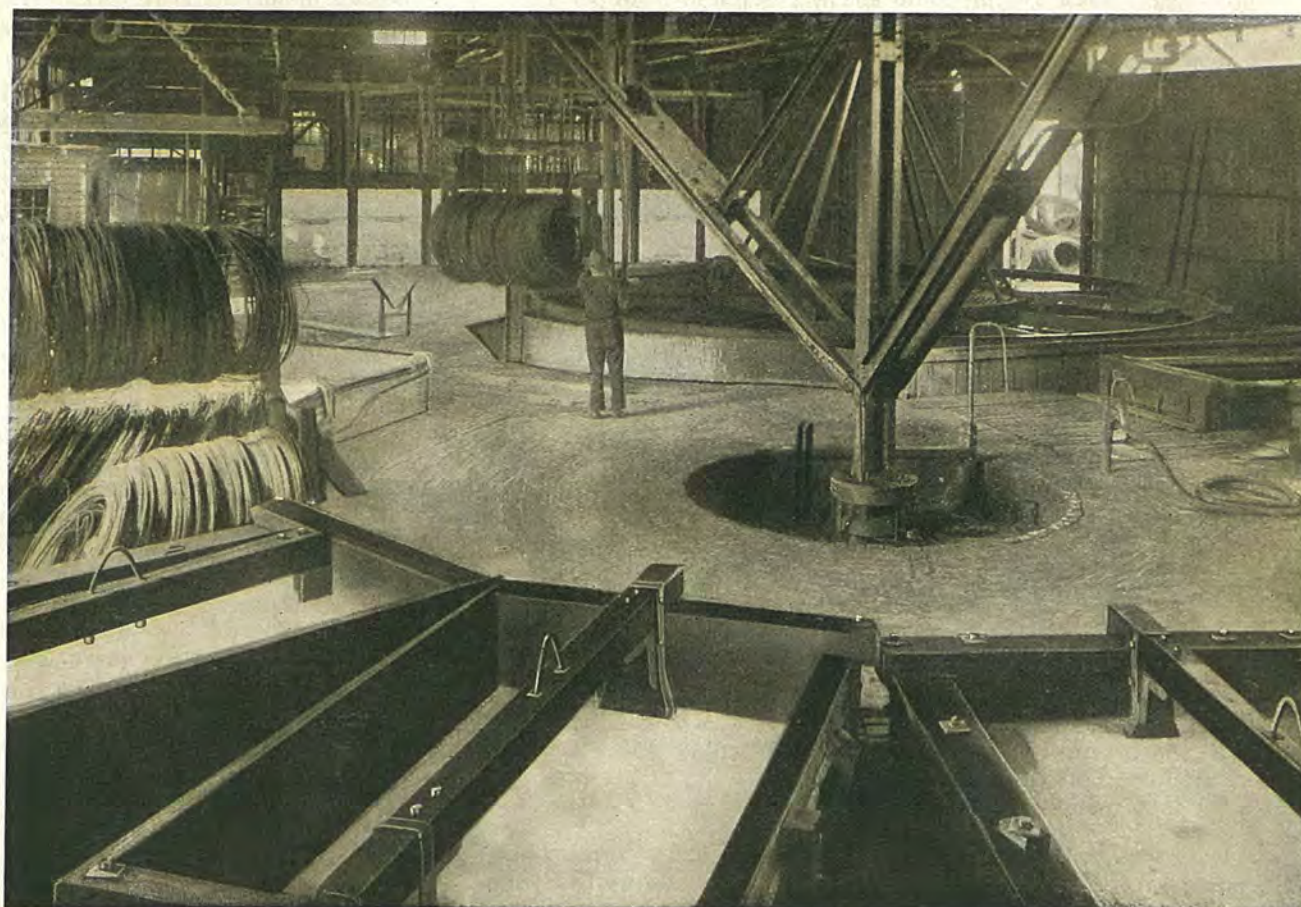
The administrative building and approach to the works are flanked by trim lawns, in keeping with the general orderly cleanliness evident throughout. The mill buildings cover 310,000 square feet of floor space, and are situated on 21 acres of land adjacent to the steel works.

The Company, in pursuance of its policy, is continually modernising and increasing its plant to ensure that Australia's needs may be fully met at all times in the most efficient manner. The plant is of the most efficient type, combining both British and American practice with the results of intensive research work on equipment best suited to Australian conditions.

PRODUCTION, MATERIALS USED AND WAGES PAID

Since manufacture started at the Wire Mills in September, 1919.

Wire and wire products manufactured	approximately	500,000 tons
Wages and salaries paid	"	£2,000,000
Steel (as raw material) to the value of	"	£5,500,000
Coal and general stores	"	£2,000,000



WIRE ROD CLEANING HOUSE. Acid Pickling Tubs in the foreground, Sull Coating Frame and Ovens in the background.



WIRE DRAWING MACHINES. FOR HEAVY WIRE. DOUBLE DRAFT PROCESS.

RANGE OF PRODUCTS

This Newcastle Wire Mill is one of the most comprehensive operating to-day. The range sold under Rylands' "Waratah" brand is as follows:—

FENCING REQUIREMENTS

Plain Wire: Galvanised and Black Varnished.
High Tensile: Galvanised 850 lbs., 1,140 lbs., and
"TYEASY" 1,250 lbs. breaking strain.
Barbed Wire: All patterns, made of "CRAPO"
quality Galvanised Wire.

Wirenetting: Rabbit Proof, Sheep, Dog and all
miscellaneous sizes.
Field Fence: Woven Field Fencing "Hinged
Joint" for Sheep, Cattle and Pigs.
Star Steel Posts: All lengths.

WIRES FOR MANUFACTURING

All classes of Galvanised, Bright Drawn, Soft Drawn, Annealed, Coppered, round and shaped
wires for all manufacturing purposes.

Highest grade wires for the manufacture of springs and wire rope.

Wire is made in all sizes from 5/8 in. diameter to 36 gauge.

As an adjunct to wire fencing material, Fence Posts are also manufactured from high carbon
steel, thus affording economic and fireproof fencing.

CAPACITY OF MILLS

The total capacity of the wire mills is 1,250 tons per week, of which a considerable proportion
is sold as a finished product, namely wire of various types, the balance serving to feed the various
finishing departments having capacities of—

Wirenetting	350 miles per week
Barbed Wire	150 tons „
Hinged Joint Field Fence	90 miles „
Nails	50 tons „
Star Steel Fence Posts	20,000 „

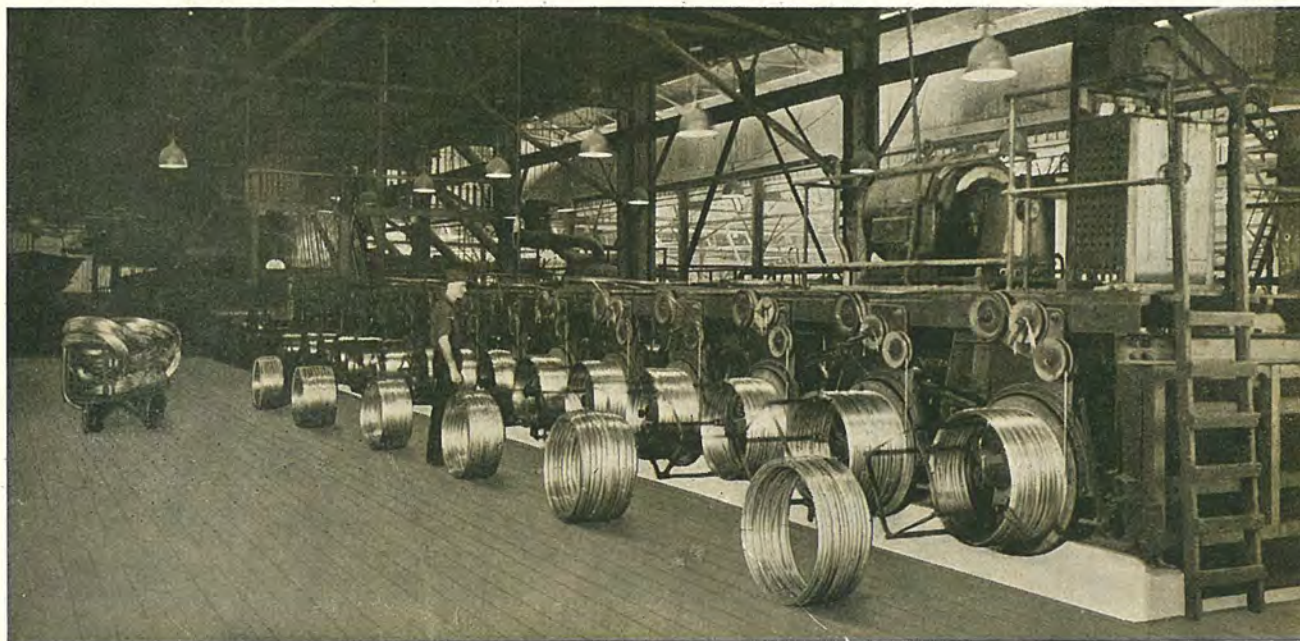


HIGH SPEED CONTINUOUS WIRE DRAWING MACHINES.

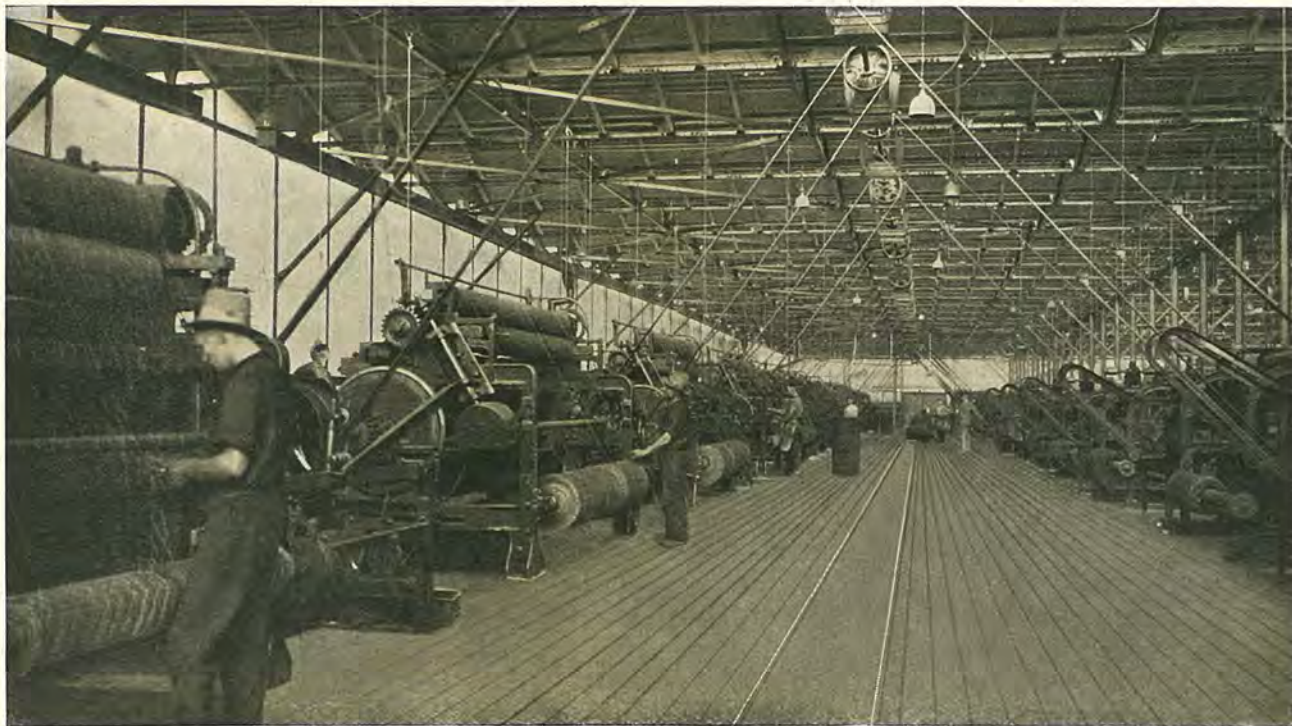
WAREHOUSE

The warehouse accommodating the finished products is over 600 feet long by 40 feet wide, and has a standard gauge railway line running its full length, facilitating prompt despatch of products with a minimum of handling, thus ensuring delivery in first-class order.

For shipping, equal efficiency is effected by means of the Company's own rolling stock, which, by direct rail communication with the ship's side, ensures products being loaded without intermediate handling. A narrow-gauge system is also installed throughout the works, and quick transport of material is aided by mobile floor tractors and light trucks.



WIRE GALVANISING—"CRAPO" PROCESS. TAKE-UP FRAME.



WIRE NETTING WEAVING—GENERAL VIEW OF LOOMS.

PRODUCTION DEPARTMENTS

Raw material of bundled wire rod, delivered in special trucks by rail direct from the steel works, is mechanically unloaded by petrol-electric mobile cranes, portion to the stock yard and the balance into the cleaning or pickling house.

CLEANING: The cleaning house is of the rotary type, arranged for bulk handling and a wide range of special work. The rods, a ton at a time, are immersed in the tubs of hot, dilute sulphuric acid to remove the scale. Subsequently, they are washed in water and dipped in boiling lime emulsion, which neutralises any remaining acid.

The drying of the rods in ovens ends the preparation for wire drawing. For efficiency, the rod handling and cleaning house, as a unit, has no superior in comparison with similar mills. The unit is capable of handling 1,200 to 1,500 tons a week.

WIRE DRAWING: The wire mills contain single and double draft blocks, powerful "Bull" blocks for handling the heaviest of wires, and continuous machines which draw the rod directly to fine netting wire without intermediate handling, also light machines for the continuous drawing of fine wires down to 36 gauge. The latest equipment installed draws 17 to 20 gauge wire direct from the rod at finishing speeds of 1,000 to 2,500 feet a minute. Copper coated wire is produced in a separate mill with its own cleaning range.

A wire drawing machine consists essentially of an iron drum or "block" fitted with a vyce to which the end of the wire is secured. The wire is first pointed in a separate machine to permit of the end passing through the die, this point then being gripped by the vyce. When the block is rotated, the wire is drawn through the die and accumulates on the block, having a gauge equal to the size of the hole in the die. Owing to the heavy pull required to draw the wire through the die, the amount of reduction at each draft is limited to a maximum of about two gauges at a time; in the finer gauges considerably less. It is, therefore, necessary to repeat the operation several times through dies successively smaller in size to produce the gauge of wire required.

Special "continuous" machines effect 2, 3, 4 or 8 reductions with only one handling of the material.

ANNEALING: The process of wire drawing causes the wire to become harder and less ductile, particularly in the finer gauges. While this hard wire is suitable for many purposes, other uses, such as weaving, tying, etc., require the wire to be soft and pliable.

This change is effected by loading the wire into steel annealing pots holding two to three tons. These pots are then charged into furnaces, where the whole mass is brought up to 650 deg. C. to 750 deg. C. according to requirements, and then allowed to cool off slowly.

PATENTING: Medium and high carbon wires are subjected to a special heat treatment in the patenting plant (equipped for both air and lead quenching), which has a capacity of 200 tons of rods per week. This department prepares rods for the production of the highest grade of rope and spring wires and high tensile fence wire.

GALVANISING: The production of galvanised wire represents a large proportion of the output of the wire mills, and the equipment comprises three heavy 30 wire units, and one 12 wire unit for fine wires. The plants are of the latest type and capable of turning out every class and finish of galvanised wire, to a total of 600 tons per week. The wires run continuously—first through a pan of red hot lead when soft wire is required, then consecutively through water quench and acid pickling cleaning tanks, a tank of flux, and finally a bath of molten spelter (zinc).

The Company is the sole manufacturer in Australia of "Crapo" Patent Galvanised Wire. This process produces the highest quality of galvanised wire, pliable and brilliant. The spelter coat, which is particularly heavy, will not peel or break under severe conditions.

BARBED WIRE: Fourteen high-speed machines make all standard types of barbed wire from galvanised wire supplied by the galvanising department. The total capacity is 150 tons per week.

WIRENETTING: The wirenetting department is equipped with 28 weaving looms capable of producing 350 miles a week of all commercial gauges and widths in meshes from $\frac{1}{2}$ in. to 4 in.

FIELD FENCE, "HINGED JOINT": The most modern type of machine is used for the manufacture of this product, and is capable of making a full range of every size of commercial field fence.

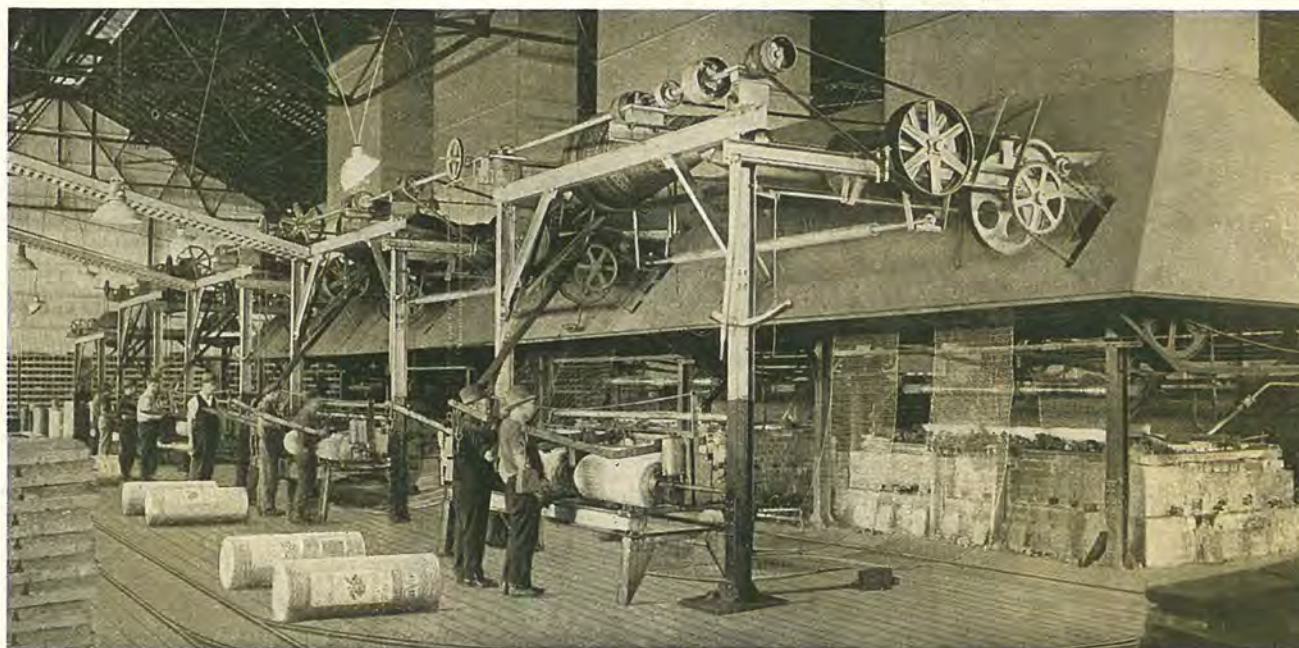
NAILS: The wire nail department is equipped with high-speed machines, with a total capacity of 50 tons per week (for all commercial sizes and types).

MISCELLANEOUS: The extensive wire products department produces oxy-acetylene welding rods, electrodes, wire strand and stranded clothes lines, chain mesh netting, florists' wire, special wire for screw stock, and wire ties for wool dumping. The keyhole type of wool dumping tie made from patented wire has very materially reduced the cost of binding bales.

TESTING AND LABORATORY

The Company maintains an extensive technical department with physical and chemical laboratories, in order that production may be under strict technical control. Much research and developmental work is continuously being carried out to ensure the maintenance of a high standard of quality in the large range and variety of products which are now manufactured.

Before the finished wire is despatched, samples are taken from the ends of each coil and subjected to physical, galvanising, electrical conductivity or other necessary tests.



GALVANISING OF WIRE NETTING BY CONTINUOUS PROCESS. SHOWING GALVANISING POTS AND WINDING FRAMES.

The chemical laboratory is equipped with facilities for rapid analysis of all raw material for the necessary determinations required for the control of production processes and for the chemical testing of finished products.

ENGINEERING DEPT.

Engineering and service workshops, complete in modern equipment, are available for all repairs and for construction of new buildings and machinery. The practice of the Company is to design and manufacture its own equipment; thus, apart from a few special wire drawing and processing machines, the plant has been designed and built in Australia.

Tools and spares, not only in these service workshops, but throughout the whole plant, are mounted on shadow boards, thus ensuring orderliness and the keeping of all parts in good condition. A general store caters for all requirements of the engineering and production departments.



30 WIRE PATENTING FURNACE. For Heat Treatment of Rope and Spring Wires.

CLEANLINESS AND SAFETY

Change houses are equipped with showers and washing facilities, with hot and cold water, and steel clothes lockers. A well-equipped ambulance room is available for all emergencies. Foremost in the minds of the management is the safety of their employees, and to this end no effort has been spared to ensure safe and comfortable working conditions.

All machinery, gears, emery wheels, and belts are guarded, and the principle of "Safety First" has been instilled into, and is practised by the men, who realise the benefits thus afforded them.



GENERAL VIEW OF MACHINE SHOP.

Showing General and Individual Machine Shadow Boards for Tools and Jigs.

Wherever practicable, machinery is equipped with safety lines, and the easy manipulation of these lines prevents serious complications in the event of a mishap.

The maintenance of all sections of the plant and yards in orderly and clean condition, with clear vision for traffic, is a valuable factor in reducing to a minimum any possibility of accident.

The results achieved are apparent from a comparison of accidents prior to the inauguration of an intensive safety campaign in 1927 with the last statistical period. Accidents per 100,000 working hours in 1927 were 19, as compared with 1.75 for the latest period.

Lysaght Brothers & Company Ltd.

SYDNEY, N.S.W.



AERIAL VIEW OF LYSAGHT BROTHERS & CO. LIMITED WORKS, PARRAMATTA RIVER—SYDNEY.

LYSAGHT BROS. & CO. LTD., originally a branch of John Lysaght Limited of Bristol, England, was established in 1884 for the purpose of manufacturing wirenetting, etc.

Sydney was chosen as the most favourable locality, as at that time there was a duty of £3 per ton on wirenetting imported into New South Wales, which somewhat compensated the manufacturer for the higher wages that had to be paid, and helped the firm to compete with the foreign-made article.

The site selected for the factory was at Five Dock, on the Parramatta River, about five miles from the metropolis, where the industry has been carried on ever since with varying fortune.

Commencing in a quite small way, with three or four machines, the factory was gradually enlarged as the demand for netting increased, and it became recognised that wirenetting was the only remedy for the rabbit scourge.

Unfortunately, after the lapse of a few years, just as the industry was becoming established, the duty was reduced, and subsequently entirely abolished. This left the firm with a very uphill fight against the competition of the world, and the product of cheap labour, and with the ever-increasing cost of Australian labour the works were carried on at a heavy loss for some time.

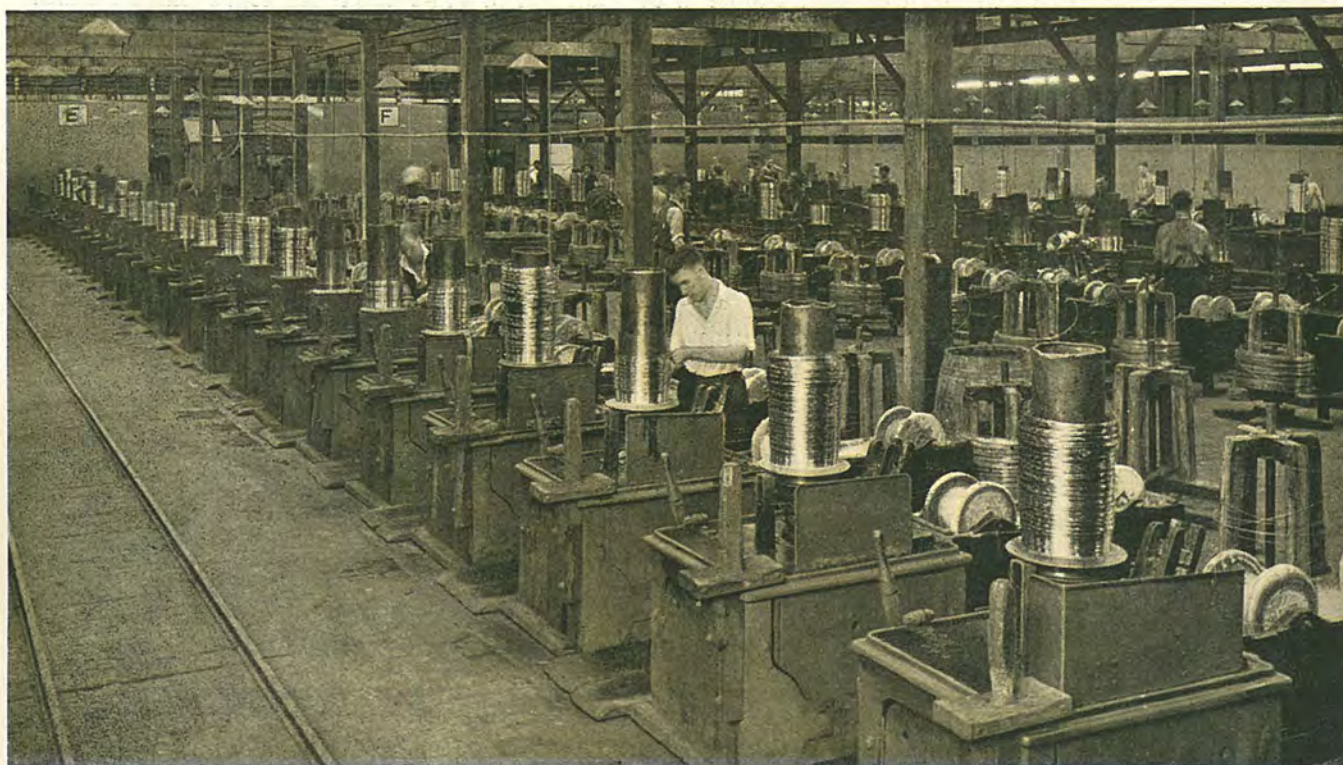
The late Mr. John Lysaght made a special visit to Australia to discuss the situation, and it was seriously thought of closing the factory.

Finally it was decided to make a further effort to continue operations, and a new company was formed, under the present title, with additional capital. More machines and plant were laid down at considerable cost. Mr. John Lysaght, one of the "Fathers" of the industry, was the first to abandon the old hand machine in favour of the manufacture of wirenetting by mechanical power. It was under his personal supervision that all the latest improvements were introduced.

In the early days of its existence the company had a serious obstacle to contend with in the prejudice which then existed against Colonial-made goods, but in the course of time, not only was this overcome, but buyers came freely to admit the superiority of the locally-made article.



CLEANING DEPARTMENT WHERE RODS ARE PREPARED FOR THE WIRE DRAWING OPERATION.



A SERIES OF WET MILL DRAWING BENCHES.

There are seven benches of twenty-eight continuous blocks each, drawing up to six holes continuously.



ANNEALING SHOP FOR HEAT TREATMENT OF WIRE.

It was largely due to the fact that buyers ultimately gave preference to its products that the company was able to win through against the keen competition of old-established European manufacturers.

With the enormous increase in the demand for wirenetting during the last few decades, European manufacturers extended their plants, and made determined efforts to capture so valuable a market, but Lysaghts boldly responded, and, with the expenditure of still further capital, the introduction of new processes and improvements, and the loyal support of its customers, held its position and continued largely to control the trade of the Commonwealth in the articles it produced.

For the first twenty years the company confined itself to the manufacture of wirenetting, and although steady, if slow, progress was made in the production of this article, in 1905—owing to the disabilities already referred to—the company was again in difficulties, and the then board of directors had again to consider whether the continuing of operations was warranted.

It was largely, if not entirely, due to the optimism and foresight of one of the directors, the late Sir Alfred Meeks of Messrs. Gibbs Bright & Co., who were largely interested financially, that yet another attempt was made to carry on.

A thorough investigation of the position was made by experts, and with the financial backing of this well-known firm, a fresh start was made and a new general manager, Mr. R. Champ, appointed.

With the rather bitter experience gained by entirely depending on the manufacture of one article, the company determined to add cautiously to its operations the manufacture of allied products, and by 1910 had firmly established its name as a producer of barbed wire and wire nails, and had also taken up the manufacture of zinc oxide. In the production of this last-named article the company was again a pioneer, and for many years was the sole producer in Australia.

Then in 1914 the war came, and, as with many other industries in Australia dependent on the importation of a large proportion of their raw material, the whole position was immediately changed.

Although a limited quantity of spelter (zinc) was already produced in Australia, all the wire required had to be imported, and, with the certain restriction in shipping, an immediate change in policy regarding supplies became imperative.

About this time The Broken Hill Proprietary Company had started to establish its great Steel Works, and had already intimated that it intended to manufacture wire rods, and the Electrolytic Zinc Company were installing their large works for the manufacture of high-grade zinc. Lysaghts, therefore, at once decided to add further to its industries the manufacture of wire, and, until The Broken Hill Pty. Co. was ready to supply the rods, to import as much as practicable under the changed conditions.

At great expense, and undergoing many difficulties due to absence of skilled labour, etc., it



succeeded in carrying on during the war period, and when the local supplies were available, had its plant fully equipped and manned, so that the industry is now self-contained, and the whole of its products are purely Australian. In addition to establishing the new industry of wire production for its own needs and for sale to the public and other manufacturers of wire products, the company also further increased the capacity of its older departments, so that to-day its general capacity and output has grown to dimensions undreamt of in its early days fifty years ago.

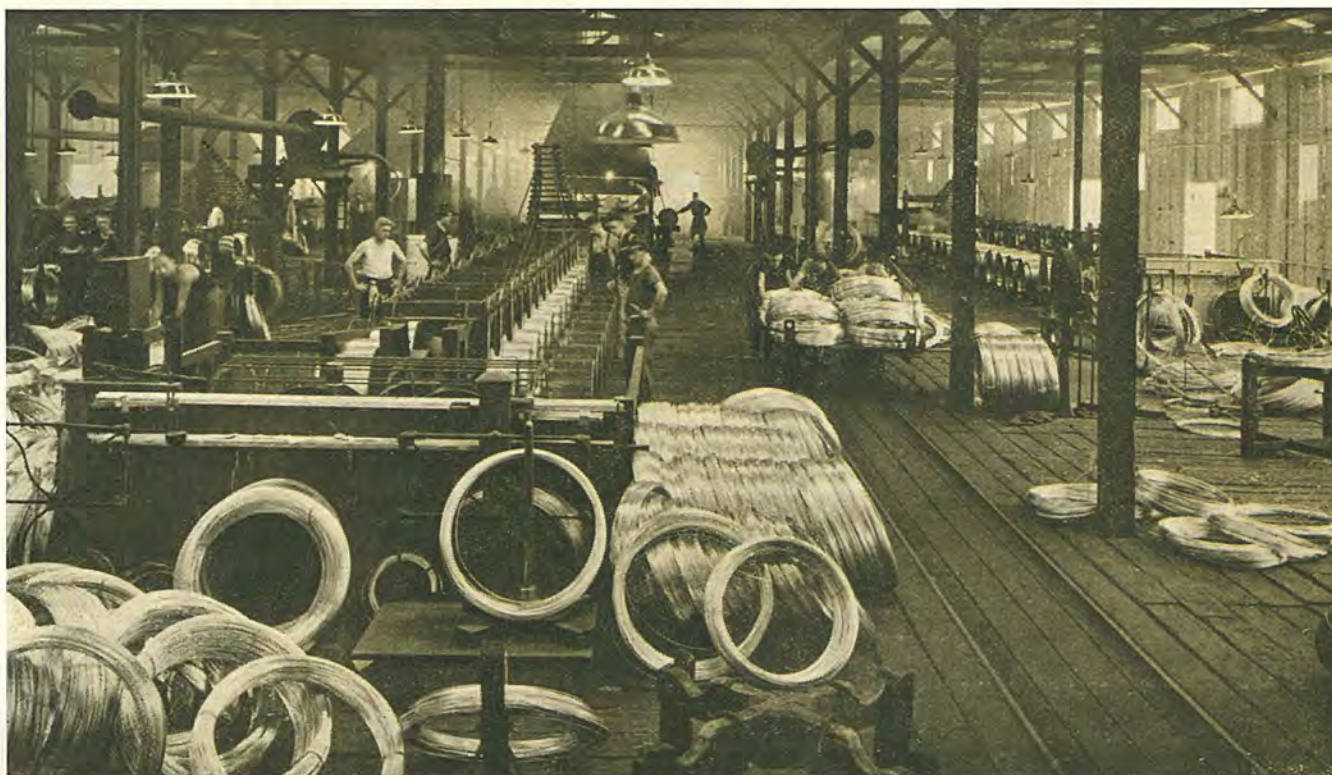
It is somewhat singular, in spite of the large amount of capital that has been sunk in this industry, and the large number of men it has employed, that until 1921-1922 no government had seen fit to give it any substantial support.

In 1921-1922, however, the Commonwealth Government adopted a policy of moderate protection, which gave the industry a somewhat more secure footing. This assistance to the industry was first in the shape of a small duty, which was subsequently withdrawn on British products and a corresponding bounty allowed on fence wire, 8-14 gauges, and wirenetting, which was passed on to the company's customers by a reduction of prices.

Both European and American manufacturers, seeing the steady growth of Australian factories, made strenuous efforts to counteract the effect of the protection allowed by the Australian Government, but by close supervision and keeping its plant and methods in line with modern improvements, the company has steadily reduced costs and so more than retained its hold of the market.

The following figures briefly indicate the growth of this industry from its small experimental beginning as an off-shoot of the well-known Bristol steel and iron makers:—

	1884-6	1904	1914	1924	1934
Capital	Branch Factory	£15,000	£150,000	£500,000	£500,000
Area	2-1/2 acres	2-1/2 acres	6 acres	16 acres	31 acres
Employees—men and boys ..	About 25	120	400	1,200	1,300
Plant, Machinery & Buildings	About £2,500	£15,000	£93,000	£360,000	£525,000
Wages, per annum	" £2,000	£10,000	£45,000	£250,000	£273,000
Sales, per annum	" £17,000	£90,000	£300,000	£800,000	£1,050,000
Wire output, per annum ..	Nil	Nil	Nil	25,000 tons	42,000 tons
Netting output, per annum ..	700 miles	4,000 miles	10,000 miles	15,000 miles	16,000 miles
Nails, output per annum ..	Nil	Nil	2,000 tons	2,500 tons	1,700 tons
Barb wire, output per annum	Nil	1907 47 tons	2,300 tons	3,000 tons	4,500 tons
Zinc Oxide, output per annum	Nil	1907 80 tons	100 tons	2,000 tons	3,100 tons



A SECTION OF THE WIRE GALVANISING DEPARTMENT.



All power units throughout the plant are operated by motors, current being drawn from the municipal supply, and 143 A.C. motors are utilised, giving over 3,000 horse-power.

Four thousand tons per month of hot rolled "rods" of various gauges and analysis are used in the manufacture of wire. The rods are first cleaned of mill scale and rust in carefully controlled acid baths, washed, and then dipped in lime solution for neutralisation. They are then dried preparatory to drawing.

Wire drawing is a cold working operation, accomplished by pulling the wire through a tapered hole of the requisite size in a block of chilled iron or other material of suitable hardness. A short length of the rod is first reduced sufficiently in diameter to pass through the hole in the block, which is fastened securely to the drawing bench. By applying sufficient tension to the pointed end which projects through the hole, the full coil of steel is pulled through and thereby reduced in diameter.

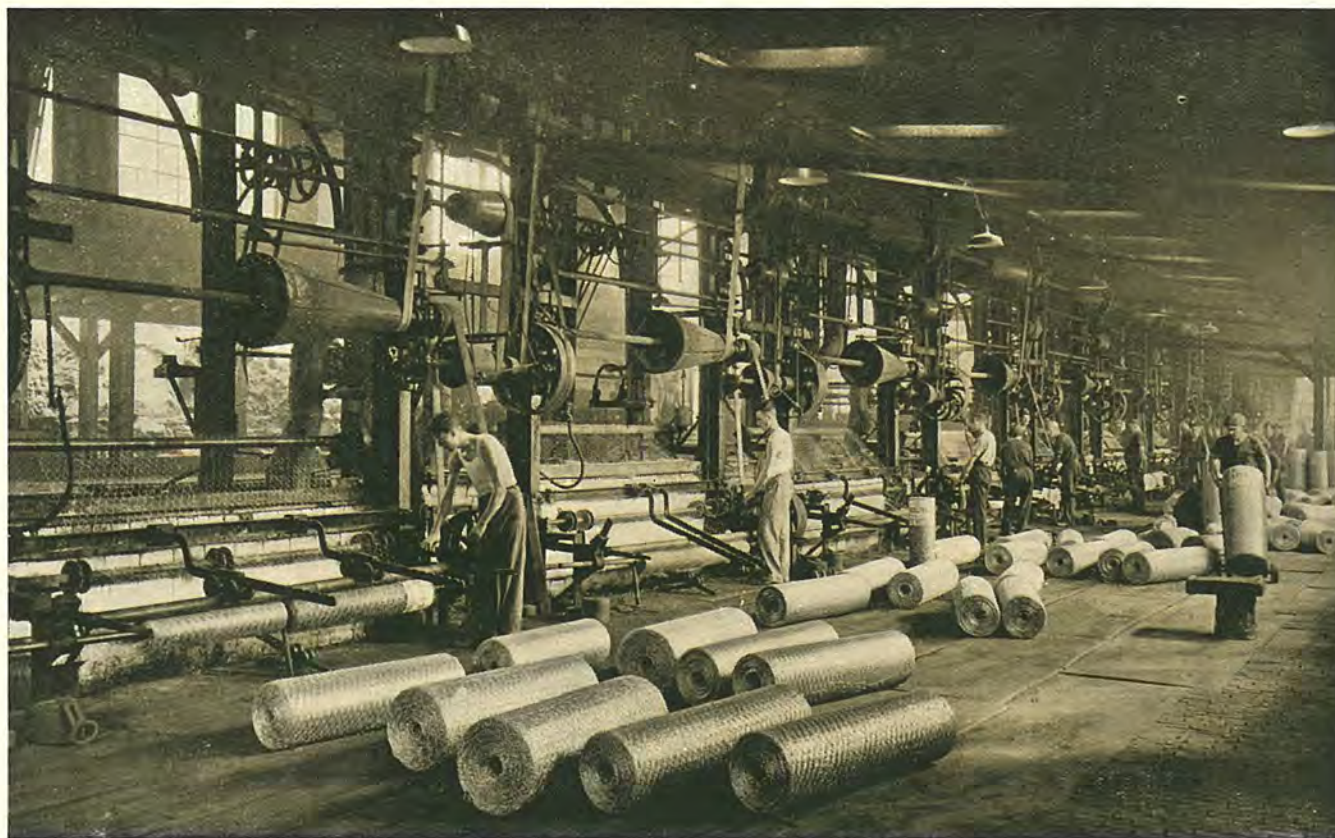
It is generally impracticable to reduce the wire to finished size in one operation, and therefore the material is usually pulled through several holes in succession, each smaller in diameter than the preceding one.

It is the practice at Messrs. Lysaghts for the carefully prepared rods to undergo one or more reductions in drawing units known as "heavy" mills. In these mills the rods are reduced in diameter by the "dry" process to gauges suitable for marketing, and also to the necessary size for feeding the "wet" mills. These latter units are used for the production of finer gauge wires of high quality required for netting and other products. In the dry mills wire from $\frac{1}{2}$ in. diameter down to 12 gauge is manufactured, whilst the wet mills produce material from 18 down to 30 gauge.

The manufacture and preparation of the numerous die blocks necessary for wire drawing form an important department, requiring a large staff of skilled operators.

Steel undergoes considerable hardening during the drawing operation. Whilst this is usually advantageous in wire, this feature is sometimes undesirable, and it is necessary to soften the wire by a heat treatment process known as annealing. For this purpose there are nine pyrometrically controlled furnaces in continuous operation.

Because of its enhanced resistance to atmospheric corrosion, large tonnages of galvanised (zinc coated) wire are produced in a large modern plant, consisting of five units. Each unit is provided with automatic pyrometric control, and the furnaces are oil fired.



A VIEW OF THE NETTING DEPARTMENT.



TRANSPORT:

Loading punts with Lysaghts products on the Parramatta River, Sydney.

The manufacture of wirenetting constitutes a very important branch of the company's activities. Netting of from $\frac{1}{2}$ in. to 4 in. mesh, and in widths of from 12 in. to 72 in. are made. These are marketed in rolls 100 yards and 50 yards in length, unless otherwise specified.

The operation is carried out in three sections:—

- (a) The winding of portion of the wire into spiral form for weaving loom tubes.
- (b) The actual weaving of the fabric.
- (c) Galvanising.

Large quantities of wire nails of all descriptions are made, ranging from heavy deck spikes and the like, to small panel pins and shoe rivets. Other articles of a similar nature include staples, clouts, sheet nails, etc.

Zinc oxide is manufactured in a plant of the company's own design, which comprises seven distinct units. Many grades are marketed which are largely absorbed by the chemical, rubber, and paint industries.

A feature of Messrs. Lysaghts is the large and well equipped engineers' assembly and repair shop, which, in addition to all maintenance work, undertakes a great deal of the construction and assembly of new plant.

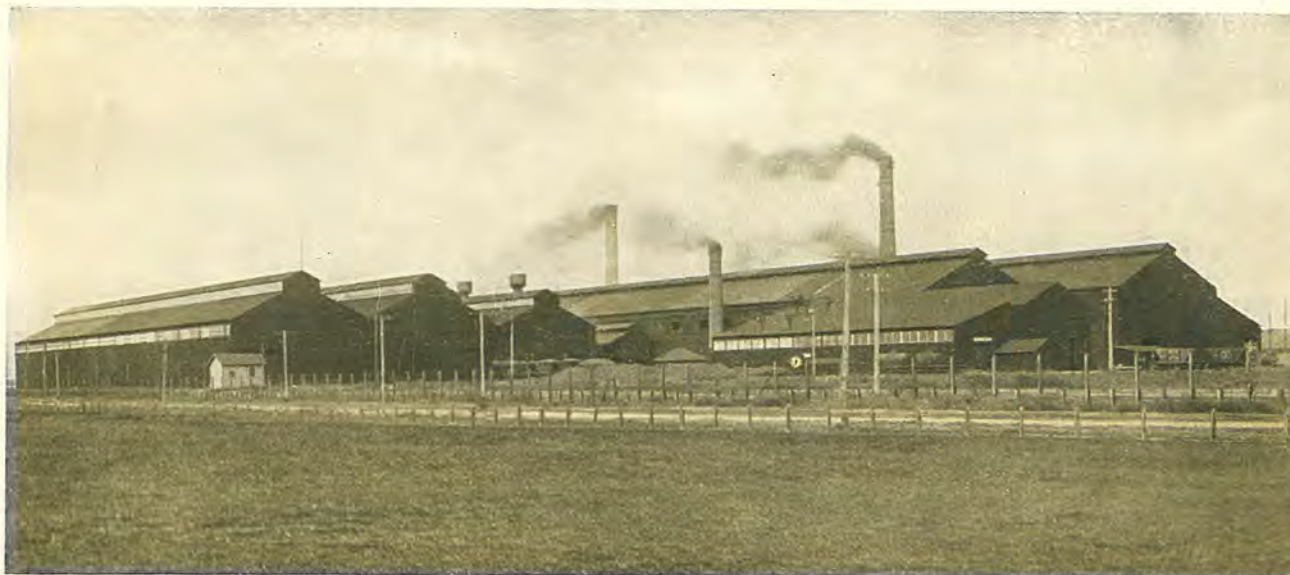
The layout of the plant was so well chosen as to allow of the internal distribution of materials largely by gravity, assisted where necessary by modern conveying devices.

Up-to-date chemical and physical laboratories enable both raw materials and finished product to be subjected to close and regular examination.

The works are situated on the banks of the Parramatta River, Sydney, and the large wharf has sufficient accommodation for five or six 150 ton lighters. These are utilised for the shipment of a considerable proportion of the finished product, the remainder being transported to its destination by rail or motor lorry.

Lysaght's Newcastle Works Limited

NEWCASTLE, N.S.W.



GENERAL VIEW OF WORKS.

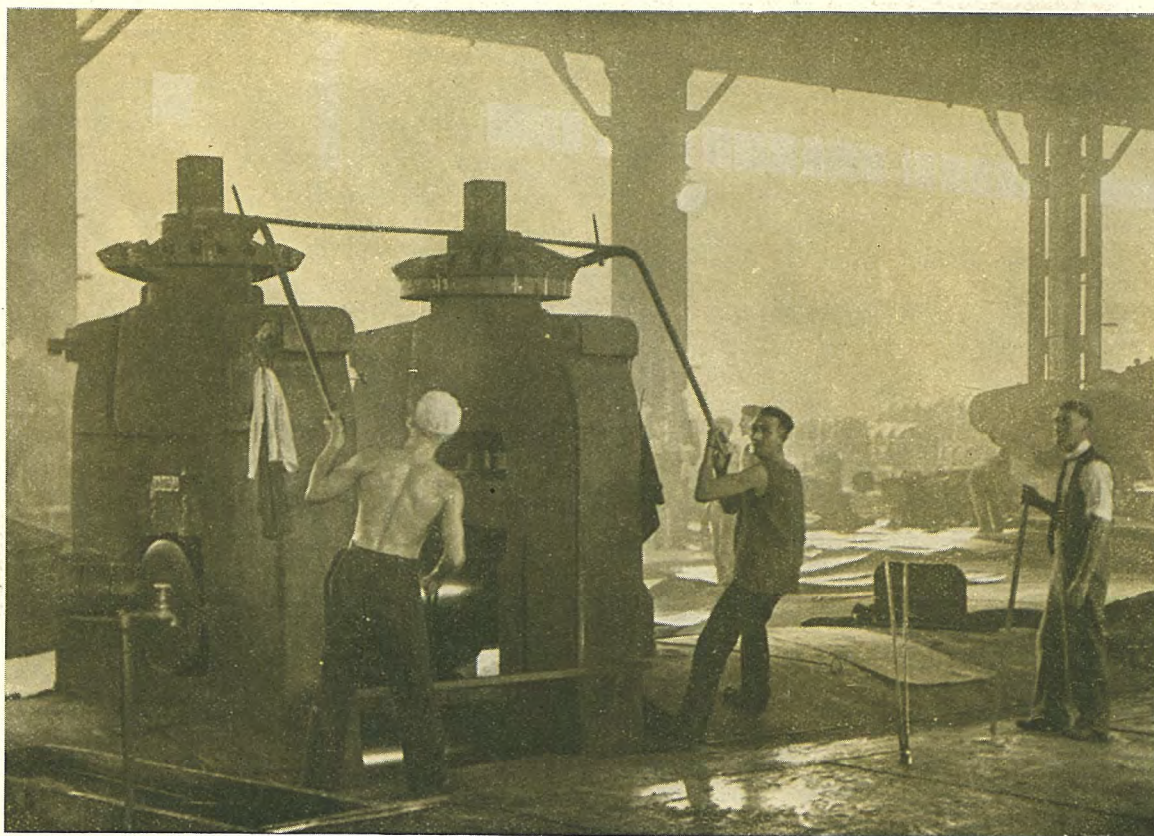
THE production of galvanised and black sheets from Lysaght's Works, Newcastle, represents a triumph of Australian manufacture. Over 100,000 tons of galvanised sheets are used in Australia every year. Imports formerly amounted to £2,500,000 a year. Lysaght's Works have kept practically the whole of this sum in circulation within the Commonwealth.

The works were laid out in 1919, and began production in 1921. Eight hand-operated sheet rolling mills and four galvanising units produced 40,000 tons a year. Within ten years the number of rolling mills was doubled, and six galvanising units were added, increasing the output to 80,000 tons. The practice of sheet rolling has been revolutionised within the past five years. A modern mechanical rolling unit was therefore added to the plant and is now operating, thereby increasing the output to 100,000 tons. Of all the plant assembled in the long mill building—of all that play of mechanism and muscle, of ingenuity and energy — the new mill and its operatives chiefly impress the mind and imagination. The Board of Directors has decided to proceed immediately with the duplication of this mechanical unit, thus further substantially increasing the capacity of the works.

The significance of this industry lies in the use of Australian material and circulation of wages among Australians. The works consume yearly 100,000 tons of steel bars, 250,000 tons of coal directly and indirectly, nearly 12,000 tons of electrolytic zinc, and 5,000 tons of sulphuric acid. Wages are £410,000 a year to 1,400 permanent employees, with an estimated £650,000 in wages on raw material production. The mills produce black sheets as well as corrugated and plain galvanised sheets. The manufacture of galvanised sheets involves five main processes — rolling, heat treatment, pickling, galvanising, and corrugating. All departments are housed in steel buildings, covering a quarter of a million square feet.

Low carbon steel bars, rolled in the B.H.P.'s 18 in. continuous mill, are brought to Lysaght's on 40-ton trucks and in lengths of about 30 feet. They are cut to the required size in guillotine shears and carried to the mill in five-ton lots.

The rolling mill comprises two blocks of hand-operated mills and a mechanised unit. In each of the blocks there are eight finishing and four roughing mills, and two sets of cold rolls, all driven by a 1300 h.p. D.C. electric motor, fitted with a huge flywheel weighing 160 tons. One roughing stand does the preliminary work for two finishing mills, served by separate, coal-fired bar furnaces and pack furnaces. A set of shears and an hydraulic doubler to two mills completes the plant in each block. Bars are charged by an hydraulic pusher into the bar furnaces, and heated to about 800 deg. C. before rolling. Heavy gauges are rolled singly. Light gauges may be finished in packs of up to eight sheets. Sheets or packs are sheared, separated, and rigidly inspected. Each mill is operated by ten men, and in an eight hours shift an average of five tons of sheets is rolled; but the mechanical mill, with only twice the number of men, turns out nearly 25 tons in the same period of time.



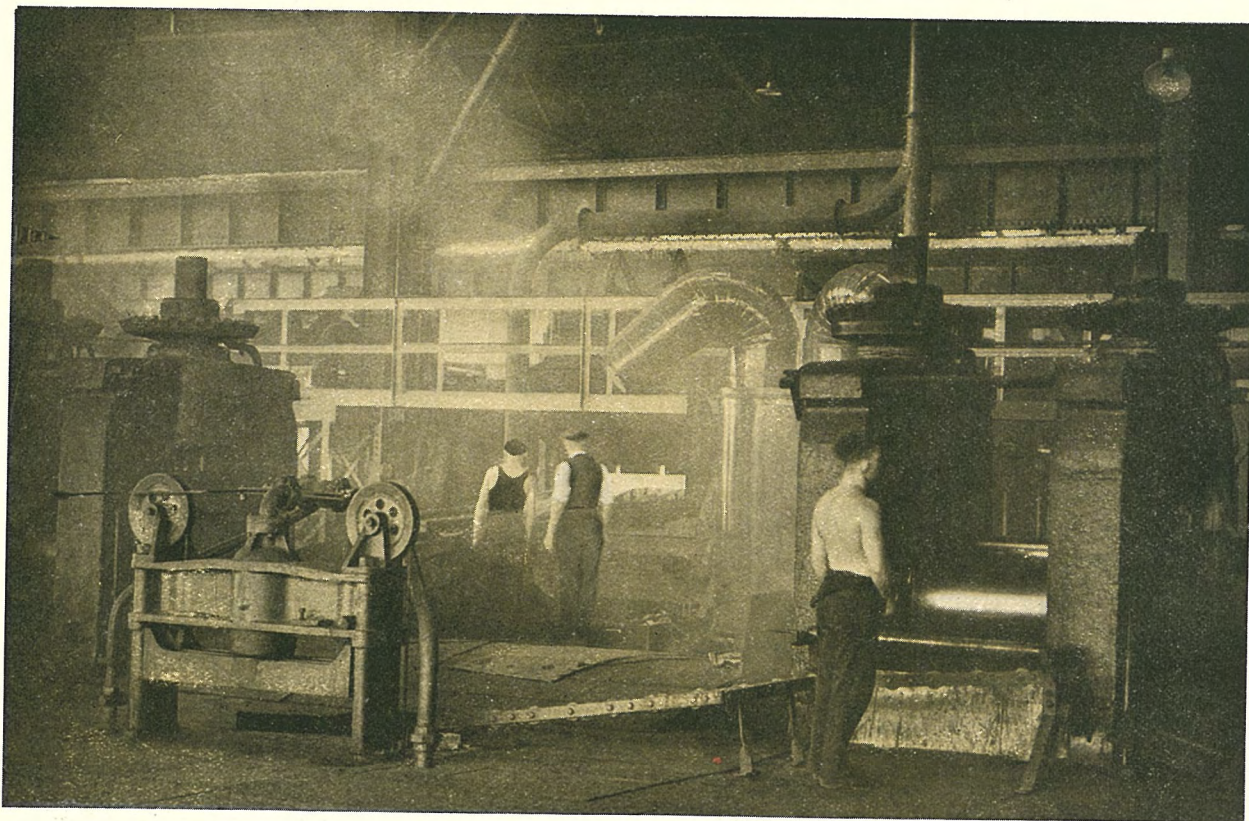
A HAND-OPERATED ROLLING MILL.

A Roller and Breaker-down are seen screwing down the roll.

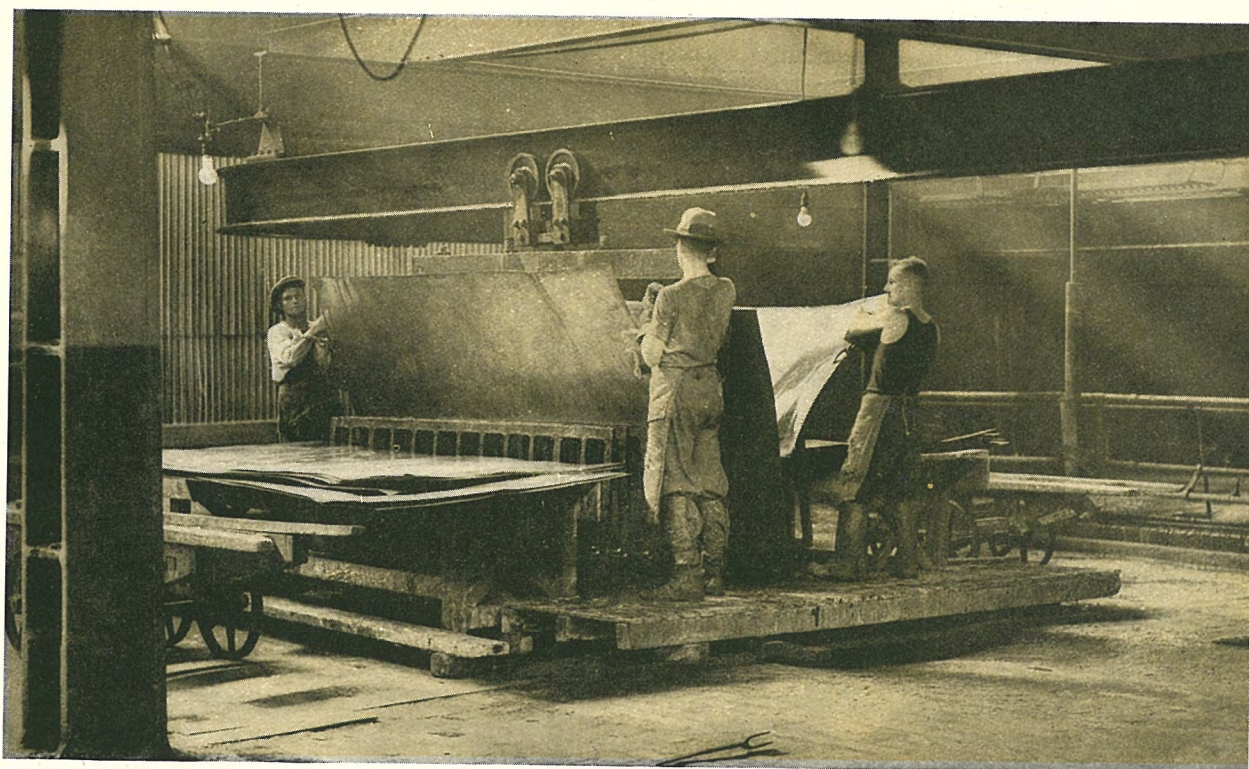
The mechanical unit consists of a mechanically-operated finishing mill, with a hand-operated roughing mill on each side of it, and a set of cold rolls attached to the end of the shaft. The mills are driven by an 1100 h.p. A.C. electric motor. Each roughing mill is served by a gas-fired bar furnace. Bars are conveyed through the furnace by a clicker-bar conveyor and carried to the mill on a wire rope conveyor. Two bars, arriving at the roughing mill, are rolled first singly and then together, and when of sufficient length are doubled on an hydraulic "doubler" press and pushed on to a return chain conveyor which carries them to a raised platform at the back of the pack furnace.

The pack furnace is also gas fired; it contains two sets of conveyors and lifting beams, which extend through the back of the furnace level with the platform, where the packs are laid on by hand. The cycle of operations in the furnace is controlled by a button switch; at a single pressure of the button, a door opens; the conveyor moves forward, passing the pack out of the furnace and lifting beams are raised, so lifting the packs remaining in the furnace off the conveyor, which then runs back. The door and lifting beams are then lowered, and the mechanism is ready for another cycle.

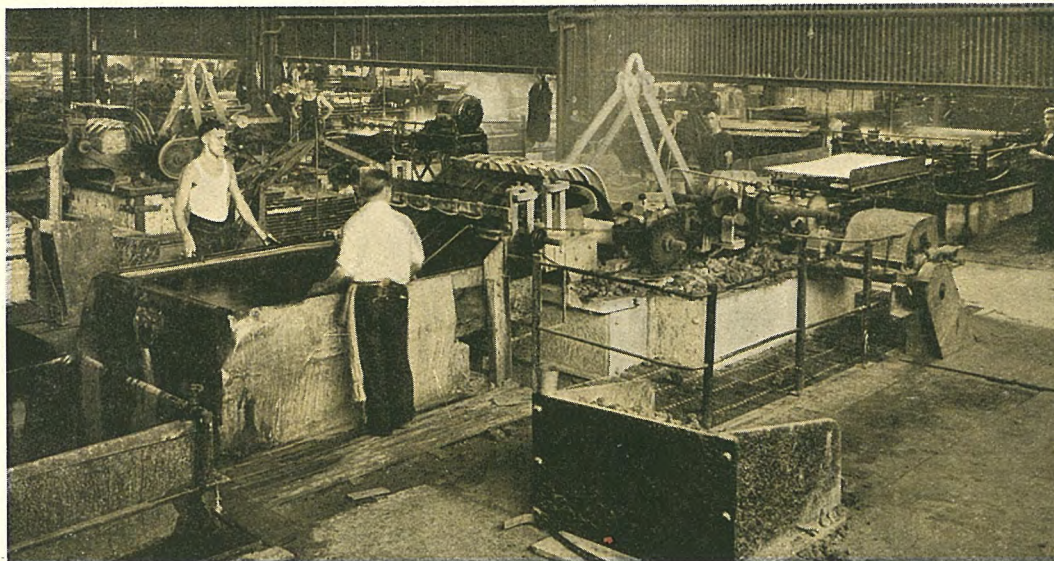
In front of the pack furnace is a tapered, electrically driven roller conveyor, which enables a pack from either furnace conveyor to run down to the finishing mill. On either side of the mill is an automatic table which is mounted on pivots at the farthest end from the rolls, and can be raised and lowered by means of a camshaft driven by an electric motor. Both carry a pair of chains driven by a reversible electric motor. With the control switch in the automatic position a pack is passed through the rolls, raised and passed back over the top of the rolls, the operation being repeated until the pack is of required length. All the movements are controlled by a photo-electric cell which works as follows:—As the pack comes out of the rolls, it cuts a beam of light falling on the cell, and as the beam reunites behind the pack, the energy produced in the cell operates switches which raise the tables and reverse the chain, and the pack is moved back over the top roll, so that the beam is cut again and the tables and chains resume their original state and motion respectively. When the pack is of sufficient length, the roller pushes the switch into the "forward" position, which nullifies the action



MECHANICAL MILL.



PICKLING YARD.



SECTION OF THE GALVANISING SHOP.

Left to right — Storage Boxes, Acid Solution Bosh, Galvanising Pot, Cooling Conveyor, Cooling Bosh.

An ungalvanised sheet is entering the pot, while a galvanised one is passing over the conveyor.

of the cell, and the pack is carried over a series of conveyors on to the shears. The whole process is continuous throughout, the furnace arrangements ensuring a constant supply of hot bars and packs.

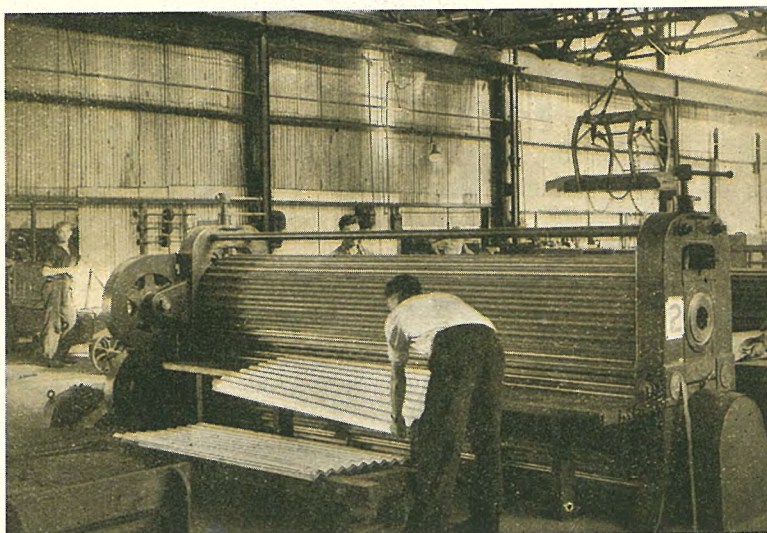
After shearing and opening, the sheets are cold rolled before moving in compact loads to the annealing department, which consists of two large continuous furnaces and several smaller units. Loads of sheets are packed on steel dishes, covered with steel covers to exclude air, heated for several hours in the furnaces and then allowed to cool slowly. The result is a soft workable sheet instead of the stiff springy product from the mill.

Before galvanising, sheets must be thoroughly cleaned of the oxide film adhering to them. This is done by "pickling" in hot sulphuric acid and a final wash in a weak acid bosh immediately behind the galvanising pot.

Zinc is kept molten by means of coke firing in a mild steel pot containing a frame on which is mounted three pairs of rolls. These serve to carry the sheets through the molten zinc, and the thickness of coating is controlled by the pressure between the last pair of rolls mounted exactly at the zinc level. A layer of molten flux covers the zinc and serves two purposes — first to flux the sheet as it enters the zinc, and secondly to prevent oxidation of the zinc.

Leaving the galvanising pots, sheets are washed and dried, and after rigid inspection are passed through branding machines ready for corrugating or flattening. The corrugating machines are of two kinds—a rotary type for lighter gauges, consisting of two fluted electrically driven rolls, fed by an automatic feeding table; and for heavier gauges a stamper type, which consists of two fluted plates, one fixed and the other moved by cranks. Plain sheets are flattened on a hydraulic stretching machine, which pulls all buckles out of them. Finally loads of sheets, corrugated or flat, are taken to the packing berths, and packed in 10 cwt. wooden cases, lined with waterproof felt, and placed in stock ready for transport.

The Lysaght product houses Australians — its manufacture employs them.



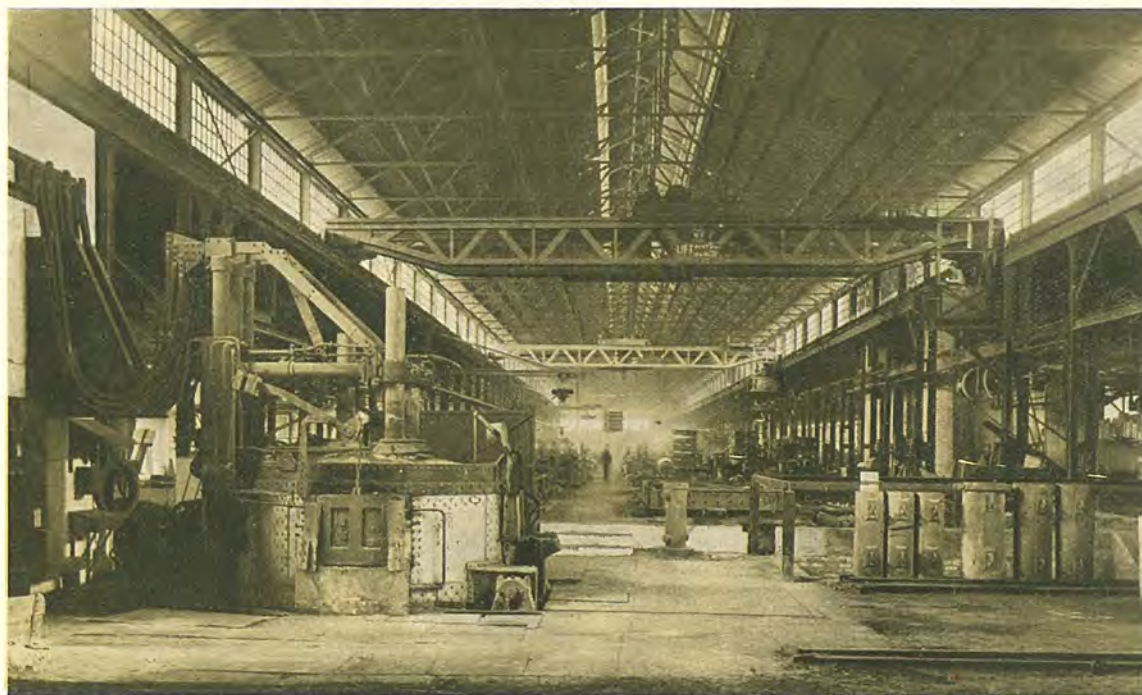
ROTARY CORRUGATING MACHINE.

On the right a bundle of flat sheets is about to enter the roll. In the foreground another bundle is just passing out of the machine.

Commonwealth Steel Company Limited

Late Vickers-Commonwealth Steel Products Limited

Newcastle, N.S.W.



STEEL FOUNDRY. 6-TON HEROULT FURNACE IN FOREGROUND.

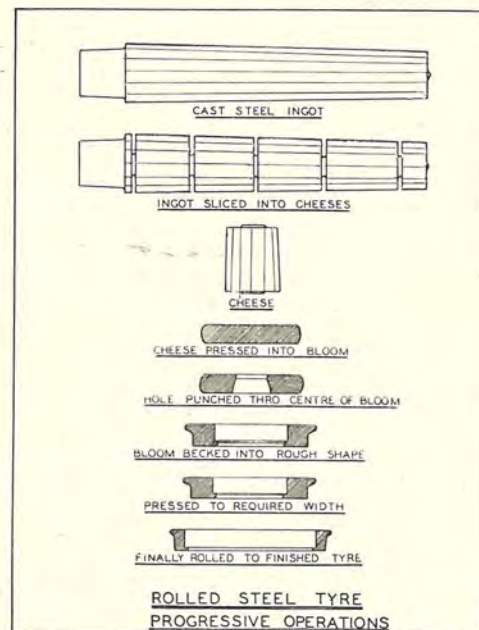
THE needs of Australia in regard to such an important item as supplies for our tramways and extensive railway systems are, to a considerable extent, furnished by the Commonwealth Steel Company Limited, whose large and efficient plant at Waratah, covering an area of 34 acres, is very conveniently situated, both for obtaining raw materials and the despatch of finished products either by rail or sea.

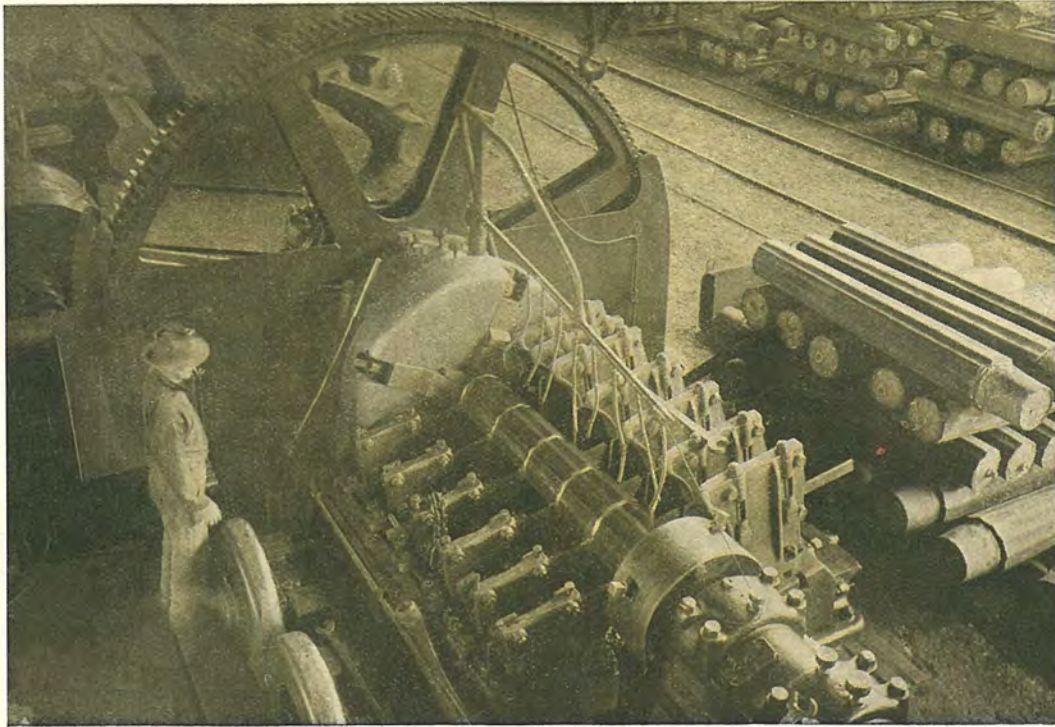
Since the formation of the company in 1917, many interesting developments have been witnessed, and at present, in addition to railway wheels, tyres, axles, and general castings, many other specialised products of importance to industry generally are marketed.

For the manufacture of railway wheels, tyres and axles, the works may be considered as consisting of three main production departments—the Foundry, the Tyre Rolling Mill, and the Axle Plant.

The Foundry is one of the best equipped of its kind in Australia, and is supplied with molten steel manufactured in a modern electric furnace of the Heroult type. In addition to cast steel wheels for rolling stock, miscellaneous castings up to eight tons in weight can be made in either carbon or alloy steels. As regards steel wheels, moulding machines are used for the preparation of the sand moulds into which the molten metal is poured in order to produce the required shape. After solidification the mould is delivered to the “dressing shop,” where the castings are removed and cleaned of adhering sand. For this purpose specially designed sand blasting appliances are largely used.

After the removal of “heads” and “risers” the castings are carefully heat treated and subjected to rigid inspection and tests before delivery to the customer, or the company’s own

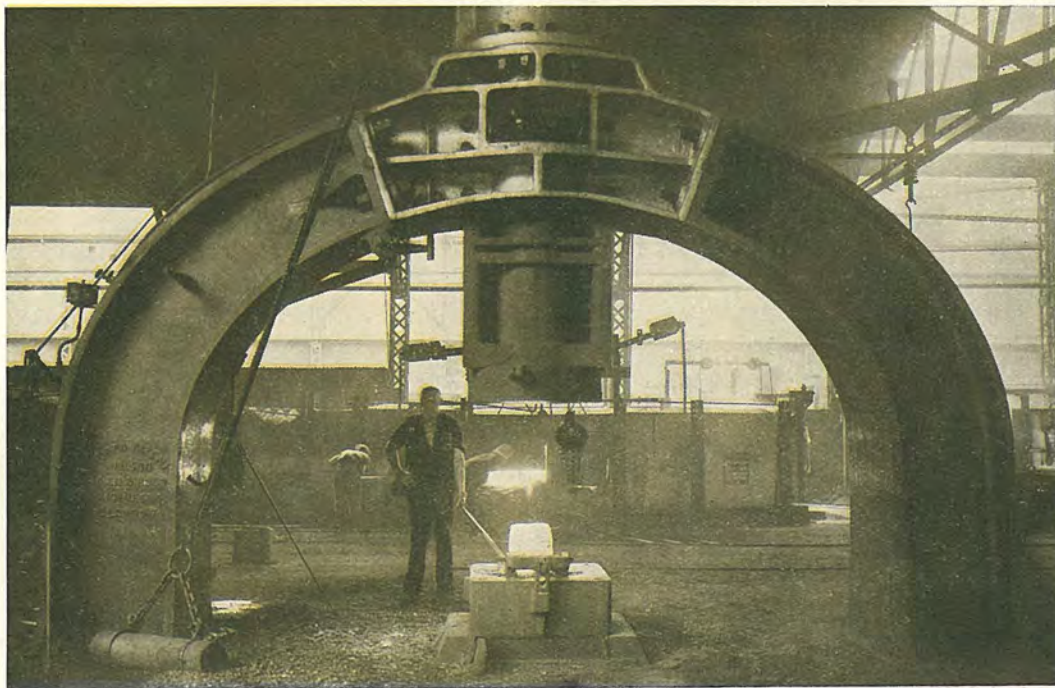




TYRE MILL. INGOT SLICING MACHINE.

machine shop, for the finishing operations. The Foundry is served by two of the many large electric overhead cranes in use throughout the works.

As some indication of the care which is bestowed upon the manufacture of steel castings, it may be mentioned that, in accordance with the best practice overseas, even the moulding sand is subjected to frequent and regular testing, and the foundry is equipped with a modern sand reconditioning plant. Wheels for railway rolling stock are fitted with heavy replaceable tyres made of wear resistant steel, and many thousands of these are manufactured annually. The tyre rolling mill for this purpose



TYRE MILL. STEAM HAMMER AND FURNACE.



TYRE MILL STOCK YARD. TYRES AWAITING MACHINING.

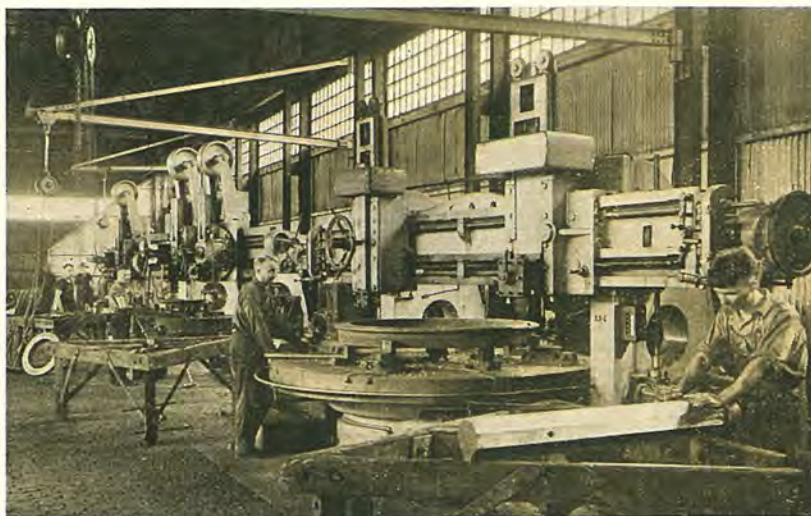
punched through the centre. The punched cheese or bloom is then transferred to a becking hammer, under which the rough outline of the tyre is developed. The partly formed tyre, now termed a "becked bloom," is then reheated and taken to the rolling mill, where correct section and diameter are obtained. The tyres are subsequently heat treated and tested and are then ready for machining either in the Company's own extensive and well-equipped machine shops, or by the customer, as desired.

The Axle Department forges, heat treats and finishes all classes of locomotive, carriage and waggon axles, for delivery to the customer, or to the Company's own well-equipped assembly shops. The axles are forged from square blooms under a 5-ton steam hammer. They are then carefully heat treated, tested, and finally, by means of special machine tools, undergo the several machining and grinding operations necessary to satisfy the exacting requirements of axles for railway rolling stock. A policy of steady progress and improvement has been consistently maintained by the Commonwealth Steel Company Limited, as indicated first by the fact that in 1926 it was found necessary to more than duplicate the plant then existent, and secondly by the marked expansion in the quantity and diversity of products manufactured during the last few years. One of the important developments made possible by the installation of a 2,000 ton hydraulic press was the manufacture of miscellaneous forgings up to 15 tons in weight, of a diameter up to 22 in. and a length up to 60 ft. For this purpose a special forging furnace was built, which is capable of efficiently heating the largest ingots at present produced in Australia.

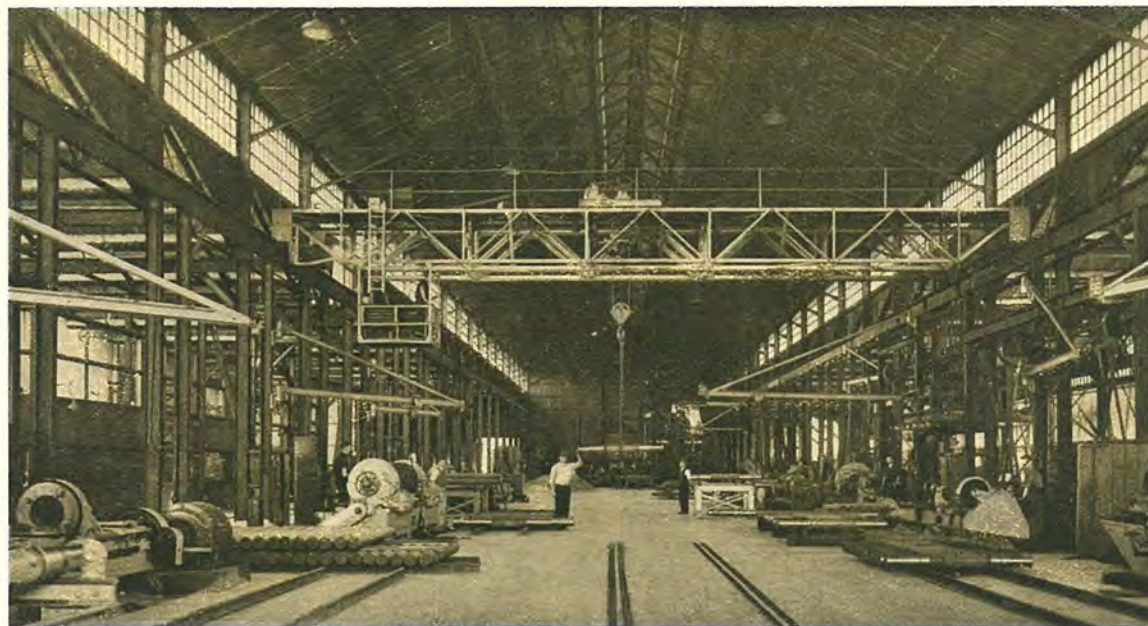
The Company has also very successfully placed on the market a product of considerable importance to the coal, gold and cement industries, in the form of forged abrasion resistant alloy steel balls, eminently suitable for use in ball mills designed for the fine grinding of numerous materials.

is capable of producing tyres ranging from 12 in. to 80 in. diameter, as required by Australian and New Zealand railways.

The tyres are made from steel ingots, produced by The Broken Hill Proprietary Company Limited, which are cut into "cheeses" by a battery of slicing machines at the tyre plant. The cheeses, each of which will produce one tyre, are then charged into the end of a "continuous" type furnace with a sloping hearth, down which they roll by gravity. When at the desired temperature, they are withdrawn, and, with the aid of a 2,000 ton hydraulic press, each cheese is flattened into a disc shape, and a hole is



TYRE MACHINE BAY.



AXLE PLANT. MACHINE SHOP WITH FORGE IN BACKGROUND.

A number of pressed steel articles of various descriptions is also manufactured.

In the field of special steels, marked progress has been made, both as regards castings and forgings. Of the numerous alloy steels produced, the heat resistant and stainless types may be mentioned, and a recent development has been the manufacture of Nitr alloy Steels suitable for use in the Nitrogen Case Hardening process. This process, which is rapidly gaining favour in the engineering world, consists of treating the Nitr alloy Steel article, at a temperature of about 550°C., in ammonia gas. In this manner an extremely hard surface is produced without impairing the ductility of the core. Besides a much greater surface hardening, the process has many advantages over the ordinary case carburising method, such, for example, as its easy application to complicated sections without fear of distortion. A large and modern nitriding furnace has recently been installed. Notwithstanding the imposing developments in the alloy field in recent years, Austenitic Manganese Steel still reigns supreme in cases where abrasion, accompanied by severe impact, is to be resisted. It is not surprising, therefore, that Manganese Steel of this type constitutes a considerable proportion of the Company's alloy steel production.

The present capacity of the works in terms of tonnage is:—

	tons per year.
Steel Foundry	3,000
Tyre Mill	15,000
Axle Plant	2,500
Ball Mills	4,000

The Company has long recognised the importance of the metallurgist and the chemist in the control of the quality of product, and in the laboratories continuous research is made to still further improve the already high standard obtained. For this desirable reason, also, close co-operation with overseas manufacturers has been maintained by the Company since its inception and officers are periodically sent abroad.



DESPATCH BAY. TRAMWAY WHEELS AND AXLES.

Stewarts and Lloyds (Australia) Proprietary Ltd.

NEWCASTLE, N.S.W.



ADMINISTRATIVE OFFICES OF STEWARTS AND LLOYDS (AUSTRALIA) PTY. LTD., NEWCASTLE, N.S.W.

AMONG the first requirements of a pastoral country is adequate water supply. Australia has few permanently running streams, so must overcome this disability by tapping underground sources. Here the first essential is water piping, hence the earliest settlements in Australia were associated with the pipe manufacturers. The largest and best known makers of this were the Stewarts—now trading as Stewarts and Lloyds—and to-day they are still the largest and best known makers.

Pioneers of artesian casings, they supplied the casings for the first bores sunk in Australia. It was their patent joint which made possible the boring for water to the depth required to tap the artesian basin. One bore in Queensland has over 7,000 feet of five inch in one string.

Later on, the enterprise of The Broken Hill Pty. Co. Ltd. further developed the steel industry, and this led to the making of pipes in Australia. It was only natural that these two enterprises—Stewarts and Lloyds Ltd. and The Broken Hill Pty. Co. Ltd.—should closely associate. Consequently an agreement was signed on August 19, 1929, for the establishment of the tube industry. The capital was provided jointly by the parent companies.

The agreement provided for the absorption of Stewarts and Lloyds (Australia) Ltd. by the new company as soon as the latter was in readiness to produce. In accordance with this provision, Stewarts and Lloyds (Australia) Ltd. went into voluntary liquidation, and by previous agreement the assets were taken over by Buttwell Pty. Ltd., who in turn became Stewarts and Lloyds (Australia) Pty. Ltd., and are now trading under that name.

Now the works are an accomplished fact, and although they have only been a few months in production, the initial difficulties are surmounted and the mill is producing at top speed. A few key men were brought out to instal and start the plant, and the steady running of the mill is a tribute to the adaptability of the Australian workmen, of whom 450 are employed.

Undoubtedly, the new plant at Newcastle is the most modern plant of its kind existing. The product of the mill is a butt welded tube, and generally this type of weld is used for the smaller sizes, having a bore of $\frac{1}{4}$ inch to 3 inches in diameter, which is the range covered by the mill. At the moment the principal demand is for the smaller sizes, and in producing these the plant at present is working continuously on two shifts, i.e., two-thirds capacity. Immediately Australian conditions warrant the larger sizes, it is the intention of the firm to develop the site by putting down a plant to supply the needs from Australian material.

The material used for steel pipe is a high quality mild steel made by The Broken Hill Pty. Co. Ltd. in its open hearth furnaces. This steel is of excellent welding quality and is rolled to very exact limits in its recently installed continuous mill. After rolling, the skelp or strip is hot coiled in lengths of approximately 700 feet, as it is necessary to deliver it in this form to the tube mill.

DESCRIPTION OF PLANT AND PROCESS

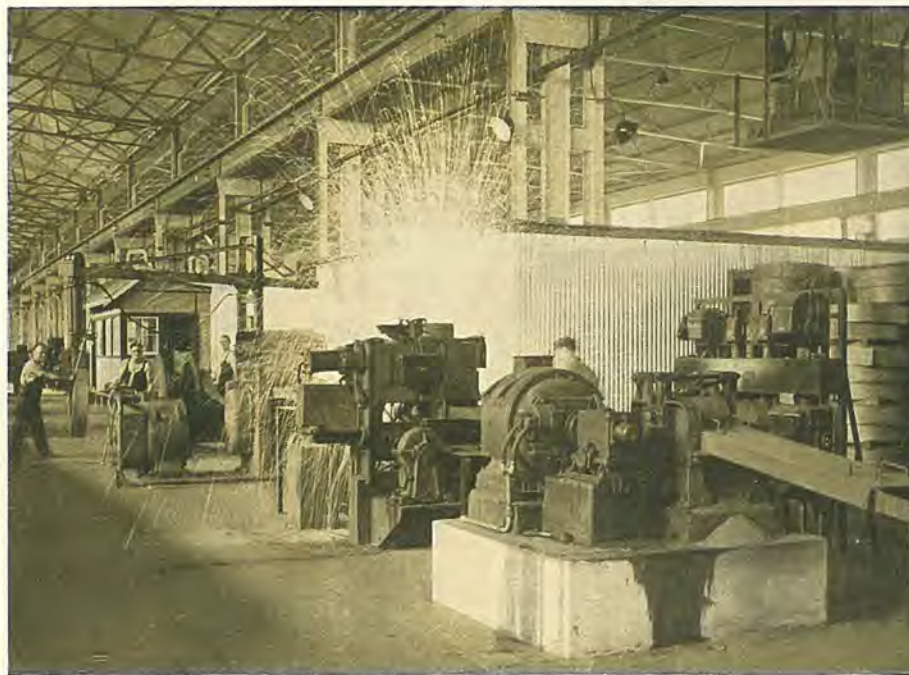
The site of the company's works is a 40-acres block of land, the administration offices being situated at the south-west corner in a position which will allow for development of the plant. The buildings face north and south, and are constructed of steel, with side lighting. A fresh water storage reservoir, with a capacity of 175,000 gallons, was constructed on the river bank. This reservoir is surmounted by a double story building, and the water is conveyed by a centrifugal pump to an overhead reinforced concrete tank of 60,000 gallons capacity. The buildings and plant are of the latest type, with ample height and efficient lighting. Full provision has been made for the comfort and well-being of the operators.

The tube mill is housed in a building 60 feet wide by 660 feet long, with ample stock space provided at the southern end for the raw material, and is an installation of the most modern type. The skelp stock is taken by an overhead crane to a special rack or coil holder. A special weighing machine, equipped with a printing device, registers the weight of each coil and the total weight passed through for the shift. Coils are placed by a crane on to a double coil-holder and fed through a skelp-levelling machine which straightens them. The strip passes through a flash-welding machine, which butt welds the coils as they run out. Immediately one coil runs out, it is stopped at the flash-welder, and the unreeler is indexed round to bring the new coil into position. This is also fed forward to the welding machine and butted against the first coil. Here both ends of the skelp are upset and welded together. The upset metal is sheared off in the same machine, and the continuous strip is again fed forward.

During this operation the strip is stationary, while the mill continues to run using up the long loop of skelp, which is run out into an inclined pit at the back end of the furnace. Prior to welding one coil to another a maximum amount of loop, or free, coil is sent out by the levelling machine, and this is controlled by a set of pinch rolls and a magnetic pulley situated in the pit. The levelling machine, welder, pinch rolls and magnetic pulley controls are all grouped together at the welding machine to simplify manipulation of skelp during welding. The cold end of the furnace is equipped with mechanically-driven water-cooled rolls to facilitate entry and reduce the drag of skelp in an inclined pit. The strip then travels right through the furnace into the welding mill.

The furnace, which is of the "tunnel" type, is extremely long and narrow, the heating agent being coke oven gas supplied by The Broken Hill Pty. Co. Ltd. The burners are of special construction and are tested out before insertion in the furnace wall. No further adjustment is required to the burners, as the ratio of gas is controlled at all times. The burners can be controlled singly and in groups for furnace regulation, and also by master valves at a control panel. In the event of a stoppage or a breakdown, the master valves only are closed. This is a decided advantage, as the setting of the furnace burners remains unaltered and a quick restart can be made.

Metal type recuperators, or air pre-heaters, are fitted to the furnace, and practically all exhaust gases are passed through recuperators. All the air to the burners is preheated to approximately 600 deg. C. It is necessary to limit the temperatures of the gases to 1000 degrees C. to avoid burning out the elements of the recuperators. An automatic control, which admits cooling air from a small fan on each recuperator, tempers the gases down to the above figure. The furnace is well equipped with pyrometers, gas, air and draught gauges. These are all grouped together at a control



ELECTRIC BUTT WELDING MACHINE

Welding ends of skelp coils together to form continuous strip.



COLD END OF FURNACE
With skelp entering and showing ends of skelp loop.

panel, and conditions of the furnace can be observed at a glance, thus being readily controlled. The furnace-lining consists of high-grade refractories, which are called upon to stand up to a temperature of 1550 deg. C. Radiation losses are kept down to a minimum by providing insulation at all parts of the furnace.

The skelp is carried on water-cooled driven rolls at the cold end of the furnace, and beyond this it is borne by easily removable water-cooled skids. At no point throughout the entire furnace does the skelp touch the bottom. This is a distinct advance on any previous methods of furnace butt welding.

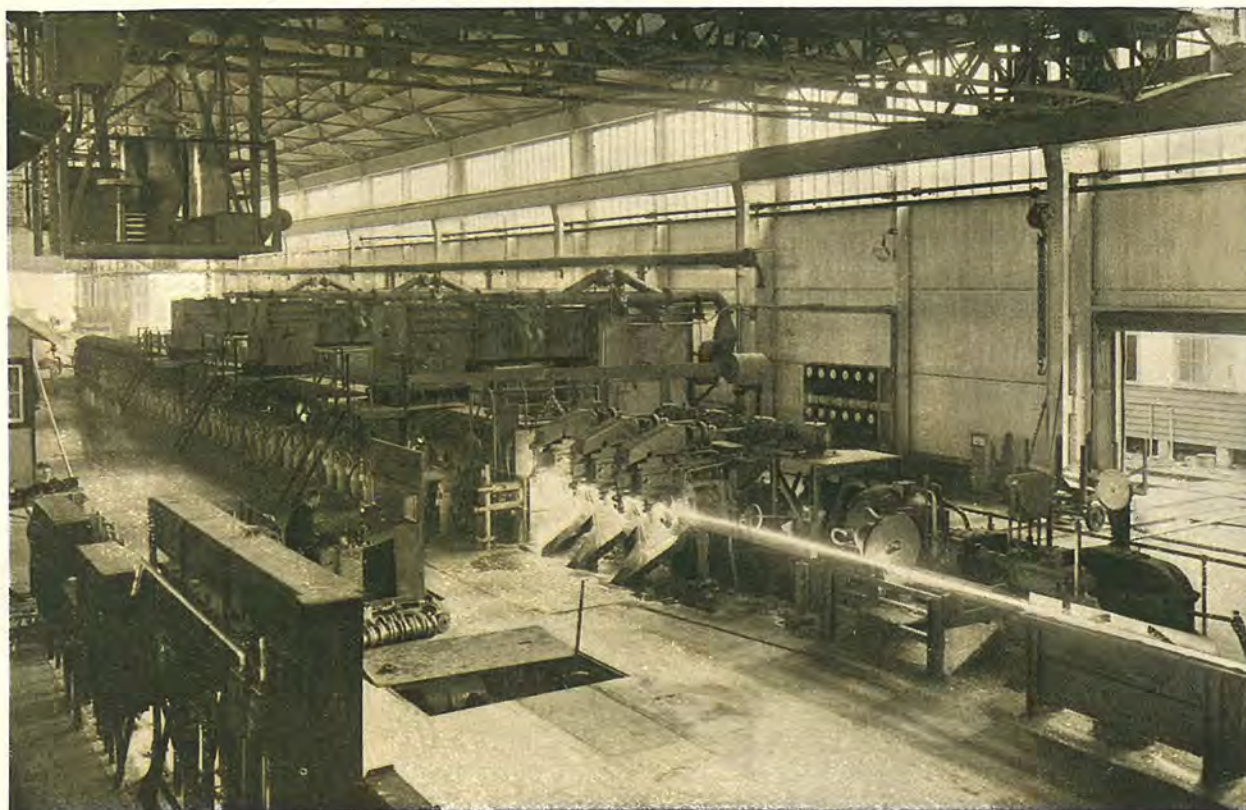
The welding mill consists of six sets of rolls comprising verticals and horizontals. Skelp is formed into a tube at the first set of rolls, of the form type, and welded in the second set. The remaining rolls reduce the tube down to approximately the finished diameter. Immediately behind the welding mill is a travelling saw, which cuts tubes off to any desired length between 13 and 23 feet. The adjustment of this saw for length cutting can be controlled electrically by an operator at the welding stand. The mill control panel, situated at a point near the welding rolls, enables complete control of the mill from this point. The mill motor is of the variable speed type, as this is necessary for adjusting welding speeds of the various sizes.

After cutting, the tubes are passed by conveyor to cooling racks. At the exit of each cooling-rack there is an escape point for switching tubes into collectors. Thus, should any stoppage occur further down the plant, it is still possible to keep the continuous mill running. From No. 1 cooling-rack tubes are normally passed to a 3-stand sizing and scaling mill. This mill, somewhat different in design from the welding mill, has a motor controlling each stand. It is absolutely necessary here that the peripheral speed of rolls be under definite control, as the tubes are at a much lower temperature, and surface defects would develop due to slippage.

A further precaution is taken here for improving the surface of tubes by passing them through nozzles furnished with an hydraulic jet automatically operated by the tube. De-scaling gives a first-class quality finish and prepares tubes for galvanising if necessary. The mill is capable of producing a scale-free tube, absolutely round, and within very close screwing tolerances. After sizing, the tubes pass on to No. 2 cooling-rack and thence by conveyor to No. 3 cooling-rack, which has a water-spraying device automatically operated by air cylinder and solenoid.

After leaving No. 3 cooling-rack the tubes are thoroughly examined for defects on an inspection table. The tubes are then hand-fed into a conveying chain and thence to a milling machine for milling the outside and inside of the tube end to remove the burr caused by the hot saw. The operation of this machine is entirely automatic. After being ejected from the machine the tubes are passed on to a conveying chain, which delivers them to a longitudinal conveyor running the full length of the finishing mill. Tubes can be automatically switched in to either set of finishing machines, of which there are two; or passed on to collecting troughs for galvanising or special finishing. After galvanising the tubes are brought back and passed on to skids at the same point of entry as black tubes normally take. A chain transporter conveys them to the automatic tube-testing machine. All tubes made in the mill are passed through an hydraulic test on this machine, two at a time. The guaranteed limit on length of cut tubes is plus or minus one inch, and this is taken care of in the automatic tube-testing machines. The tubes are filled with low pressure water and testing is automatically completed by the admission of hydraulic pressure of approximately 650 lbs. per square inch.

After testing, tubes are conveyed across to an automatic tube-screwing machine, which screws one end and passes the tube to a cross-transporter, which in turn brings the other end of the tube



WELDING MILL

In relation to gas-fired furnace, in which continuous skelp is raised to welding heat.

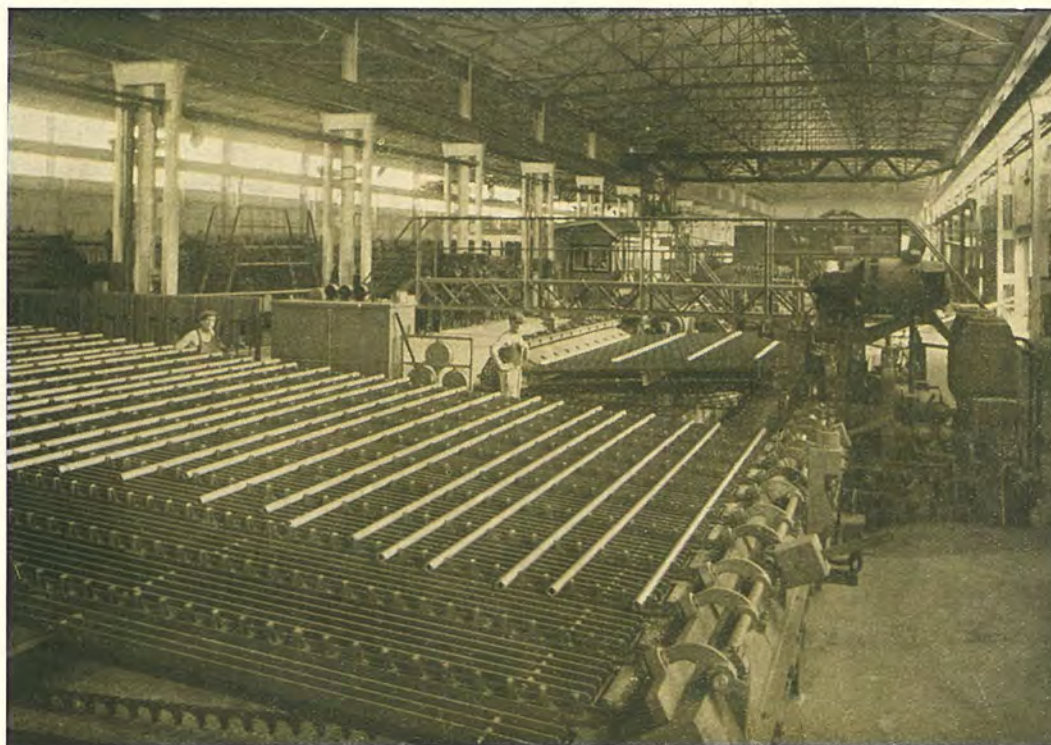
into proper relation for a second screwing-machine. From this, tubes are fed to a coupling screwing-on machine, which is semi-automatic and synchronised with the second screwing machine. On completion of this operation the tubes are automatically ejected and passed on to a conveyor chain for transporting through to the warehouse, where tubes are finally examined for surface defects—then they are bundled. The bundles are passed separately by hand to a 5-ton quick-weighing machine which records on a ribbon the weight of each bundle and also the total weight for the shift.

Tubes which require galvanising are transported in 5-ton loads by light-gauge railway from the mill building to the galvanising department, which consists of a 60 ft. span building, 270 feet long. An acid storage plant, consisting of overhead tanks with gravity feed to pickling tanks, has been installed. The rail tanks deliver acid to a small underground tank, whence it is blown up by compressed air to the overhead tanks.

"Pickling" of tubes is carried out here by immersion in sulphuric acid. The pickling machine is of an automatic type and tubes are turned over continuously with an intermittent rising and falling of the acid bath. The pickling machine is capable of dealing with two 5-ton loads of tubes simultaneously, one in each vat. Tubes are then taken from the mechanical pickler and washed in a hot still tank. A further washing takes place in the cold still tank, and they are finally immersed in a flux bath prior to galvanising. After drying, the tubes are fed-in on inclined skids to the galvanising bath, which is fired by pulverised fuel. This bath is arranged with a mechanical sinking device which gives every tube a constant time of immersion in molten zinc. The tubes are then air-blown to remove excess spelter, which would form beads inside, and are then passed down inclined skids to a quenching tank. From this point tubes are transported back to the finishing mill for screwing, testing, etc.

The galvanising of sockets, or couplings, for tubes, is also carried out in this department on a similar but smaller installation, which consists of an automatic pickling machine, hot plate, still acid vats and small fittings bath, the heating agent for the small fittings bath being crude oil.

Two processes are adopted for the manufacture of sockets, the small size being manufactured from the solid bar on 4-spindle automatic machines. The operation of these machines is extremely fast and sockets are completely finished ready for screwing. The larger sizes of sockets are also of the



**TUBES ON
COOLING TABLES.**

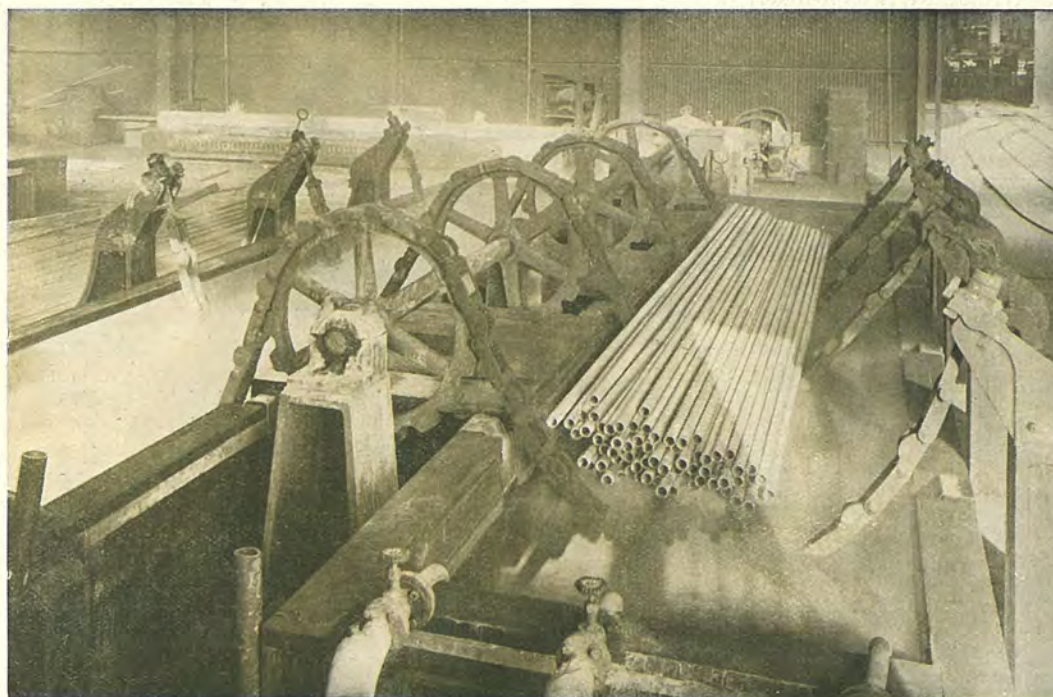
After passing through continuous tube welding mill and being cut to length by automatic saw.

weldless variety, and are made on mechanically operated forging machines. The screwing of all sockets is carried out on 4-spindle automatic screwing-machines equipped with drilling and tapping fixtures. The machines are arranged with rotating tables with loading station. Bends and tubulars are also manufactured in this department, and all are subjected to testing before despatch.

The works, as a whole, are a very efficient and compact unit, designed with one end in view, viz., the production of high quality tubes and fittings for the Australian market.

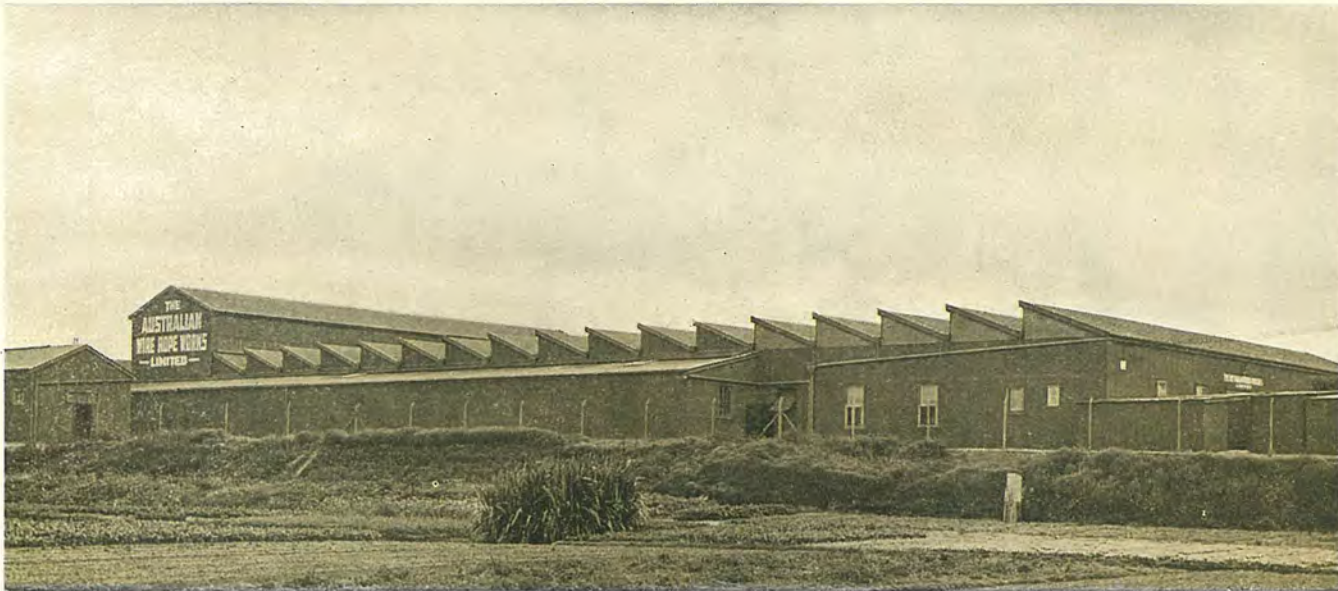
**AUTOMATIC
TUBE PICKLING
MACHINE**

Showing tubes being immersed in sulphuric acid bath.



The Australian Wire Rope Works Limited

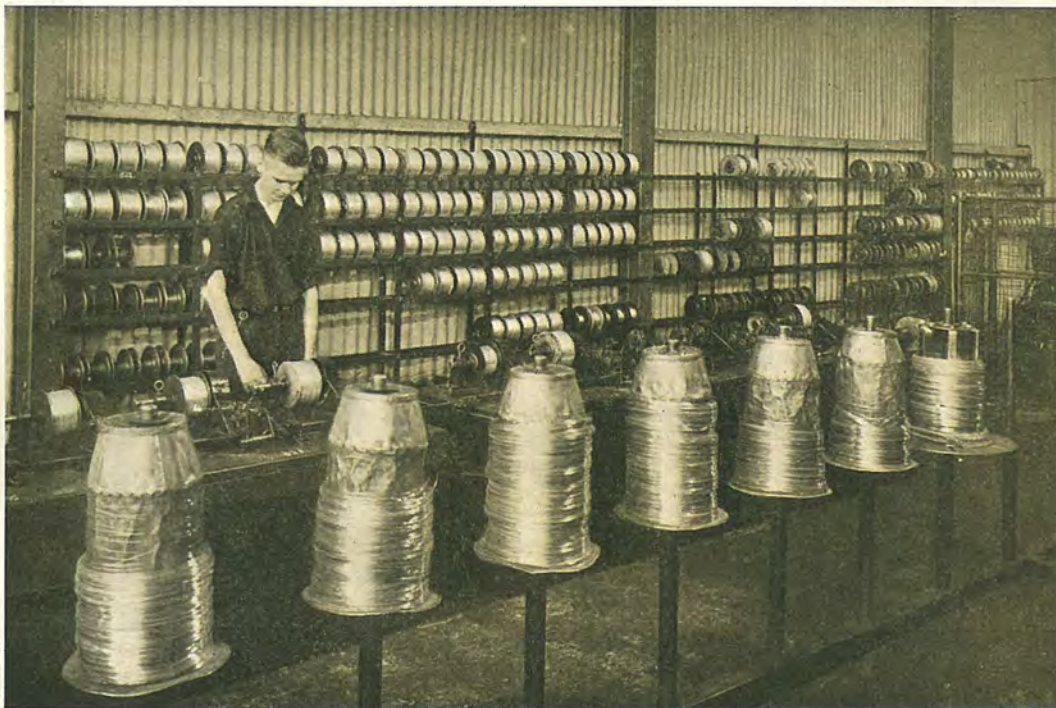
NEWCASTLE, N.S.W.



VIEW OF WORKS.

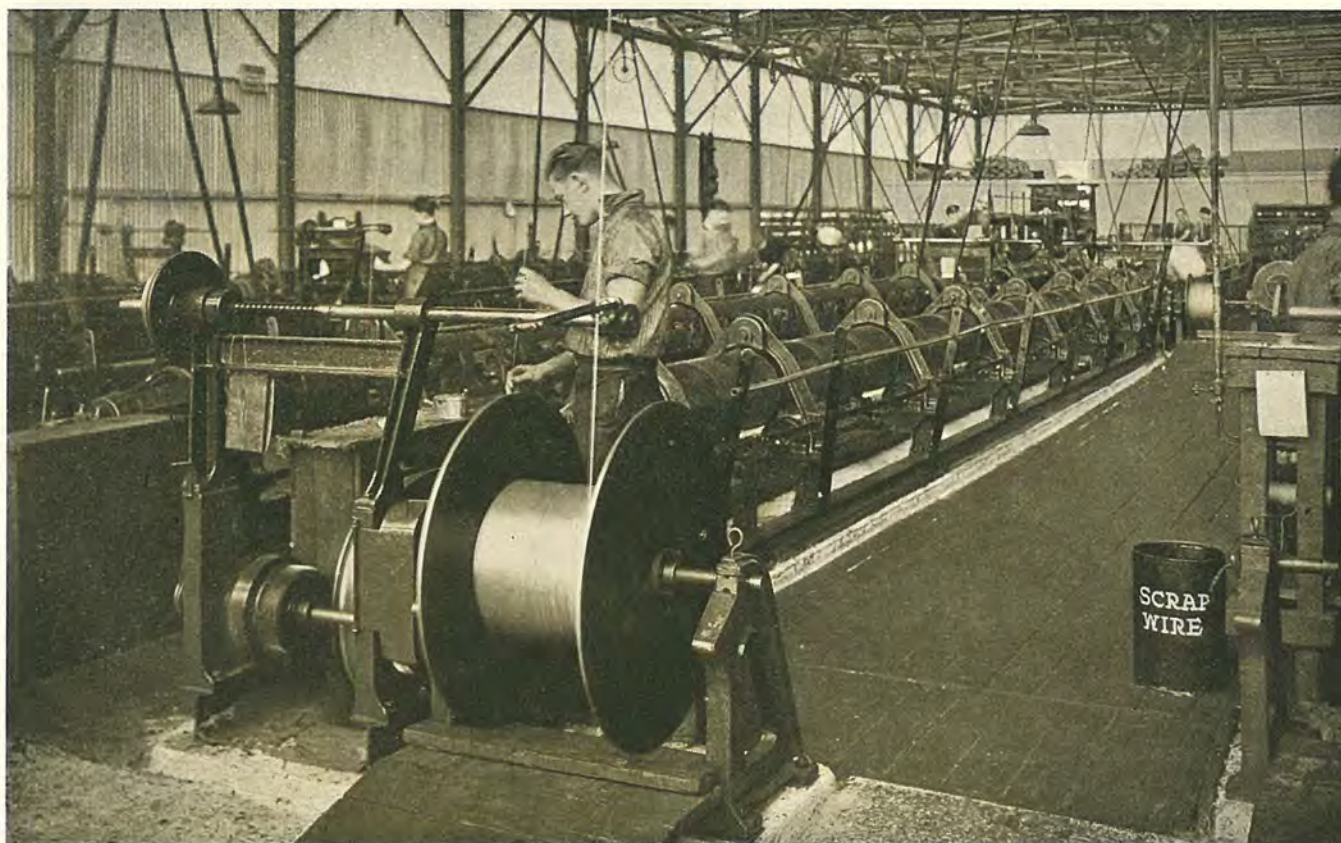
THE advent of steel wire rope manufacture has added another interesting page to the history of the steel industry in Australia, and a visit to the Australian Wire Rope Works maintains the impressions of efficiency already created by inspection of the Steel Works and other allied industries. Wire ropes are of vital importance; the element of chance must be eliminated by skilled manufacture from the finest material, the makers' responsibility necessitating rigid tests of ropes to breaking point.

The works were founded after negotiations of The Broken Hill Pty. Co. Ltd. with foremost wire-rope manufacturers in Great Britain, and on determination from a British expert report that first-class wire rope could be produced from Newcastle steel wire. In June, 1923, the Australian Wire Rope Works Ltd. was registered in Sydney. The companies associated with the enterprise were Bullivant & Co. Ltd., London; T. & W. Smith Ltd., Newcastle-on-Tyne; Allan Whyte & Co. Ltd.,



WINDING
SECTION.

Small end. First operation in actual manufacture of wire rope. Single wires being wound on to steel bobbins.



A PART OF THE HIGH-SPEED STRANDING PLANT.

The second operation in Wire Rope Manufacture. Single wires being stranded together.

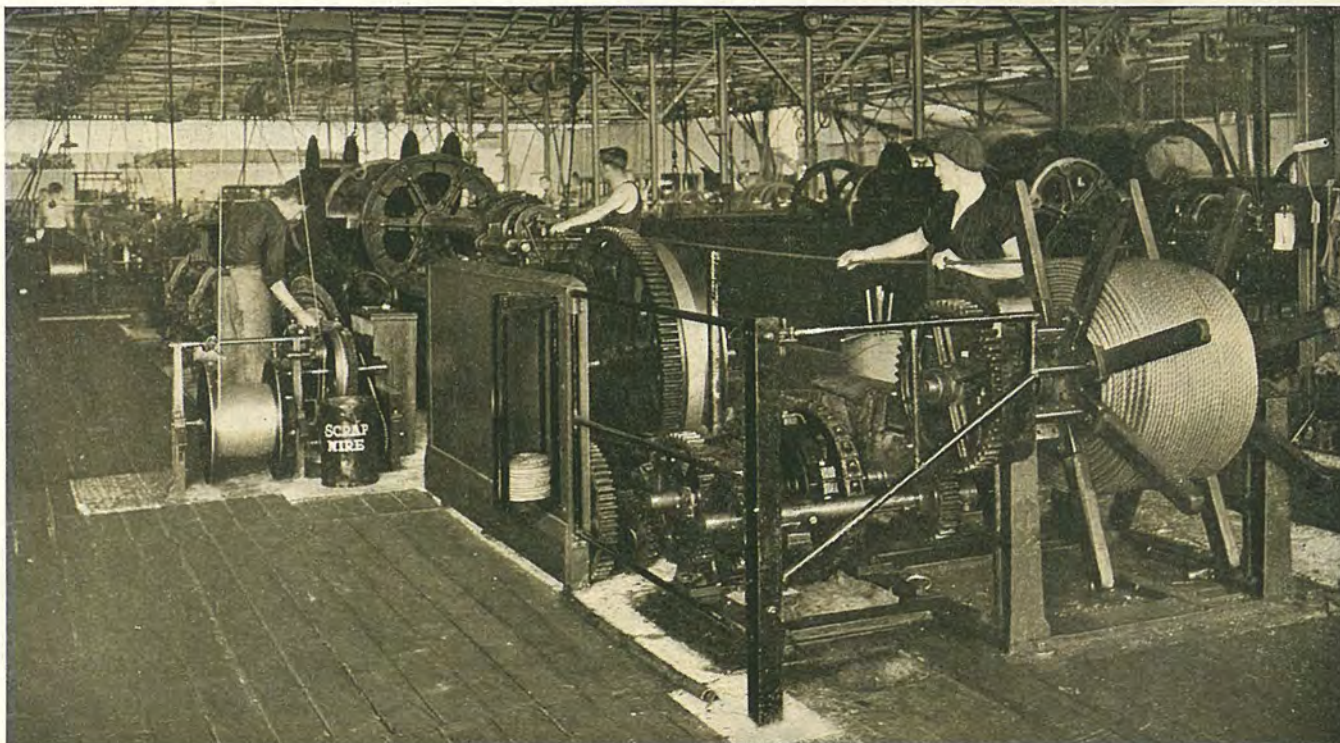
Rutherglen, Glasgow; Rylands Bros. Ltd., Warrington; and The Broken Hill Pty. Co. Ltd., Australia. The works were established on five acres of freehold land adjoining the Steel Works, and were equipped with high-class British rope-making and testing machinery. Actual production commenced in January, 1925, and since then the works have been enlarged, additional machinery installed, and progress to greater efficiency sought scrupulously for all sections of the plant. Much earnest thought has been directed toward ideal working conditions and leisure for operatives.

Extensions to the main building are at present in hand, to house equipment which will permit of a still wider range of production, including flattened strand ropes.

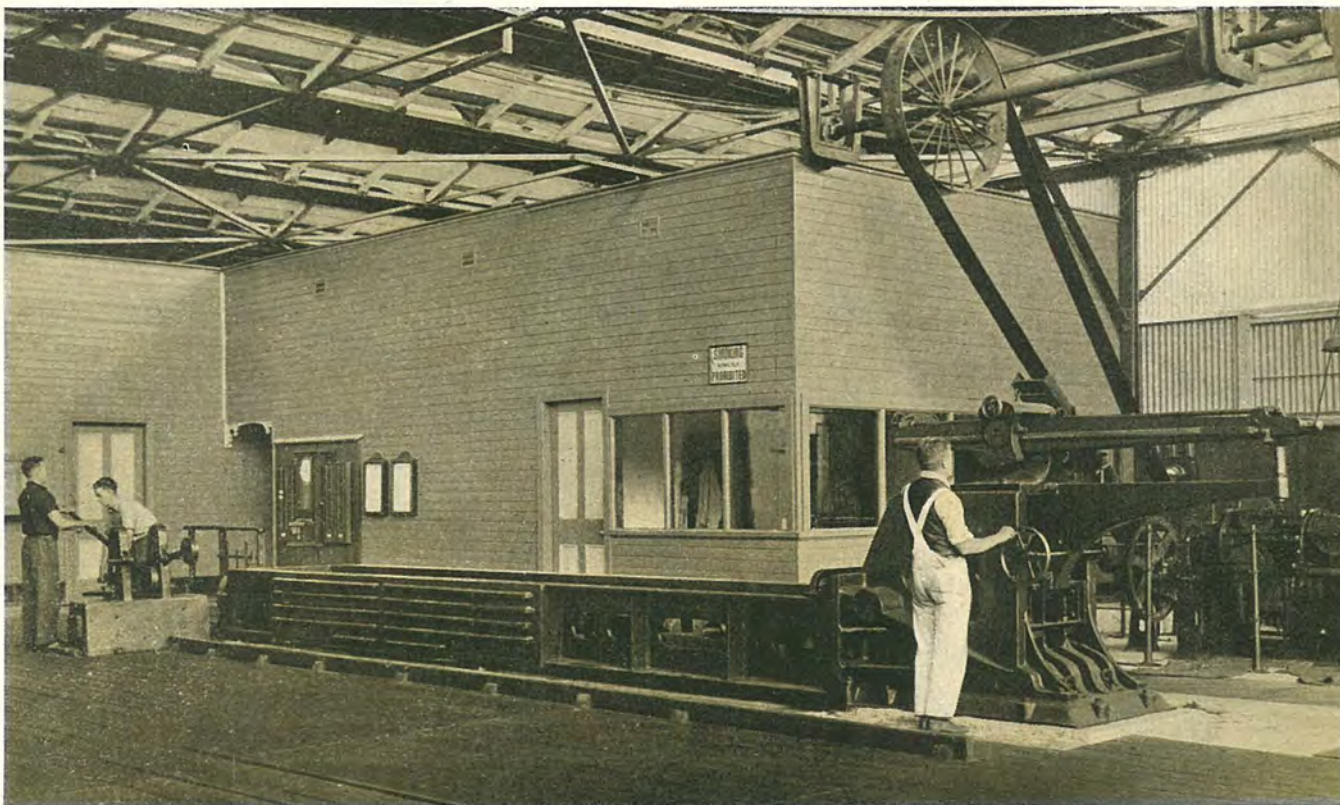
From the gleaming strands of wire to the production of the finished wire rope, the process is of the greatest interest. The first step is the choice of suitable construction of rope and type of steel best fitted for the particular purpose for which the rope is required. The next is the thorough testing of every wire at each end to ensure that tensile, torsional and bending properties are in strict accordance with British standards. All records of tests are logged for future reference. After testing, the wires are wound under slight but even tension on steel bobbins of various sizes. These bobbins of wire are placed in stranding machines, which spin the wires to form strands. These strands may contain from three to 91 wires, spun into concentric layers, and forming ultimately a perfectly round strand. The next operation is to place the strands, usually six in number, in a closing or laying machine. The strands are laid round a fibre heart, termed a main core, to form the completed wire rope. The fibre is impregnated with grease before the closing operation, and more lubricant, if desirable, is filled into the rope when closing. The final operation is the testing to destruction of a portion of the wire rope to prove it up to guaranteed strength.

To the technician, the elaborate testing plant is probably of chief interest. Fatigue, tension, torsion, and bending testing machines, and a Denison machine which will test whole ropes up to 100 tons, are installed in this department. The company issues with its products official certificates of tests. The works have been inspected by Lloyds' surveyors and approved as a testing house, and a Lloyds' Certificate is issued when required with any order.

The company manufactures wire rope from $\frac{1}{4}$ in. to 10 in. in circumference, including all constructions up to six strands of 91 wires inclusive, with weights of up to 10 tons without splicing, and breaking strains as high as 343 tons. Especially in the production of haulage and winding ropes for use in mines, the company's care in selection and testing of materials, and skilful supervision during manufacture have resulted in a product equal to the best imported.



In foreground (left) High Speed Stranding, for making small steel strands.
In foreground (centre) Closing Machine; completing operation, making a flexible steel rope. Capacity of machine, four tons.



TENSILE TESTING MACHINE FOR COMPLETED ROPES. CAPACITY 100 TONS.

The Titan Nail and Wire Pty. Ltd.

SOUTH MELBOURNE, VICTORIA.



A BATTERY OF NAIL MACHINES AT WORK.

PIONEER in the manufacture of barbed wire, Mr. John Rose arrived in Melbourne in 1888 from Dunedin, N.Z., and commenced a factory in Amess Street, North Carlton. The necessary machines were built by Mr. Rose on American models.

The venture succeeded so well that Rose entered into partnership with the late Alexander McNeil, of Briscoe & Co. Ltd., thus bringing into existence the Titan Engineering Works. The new organisation established itself in Spencer Street, Melbourne, and added to its original production the manufacture of wire nails, staples, and other wire goods. Later it commenced the manufacture of sheet metal goods, including tinware and builders' requirements.

Further progress was made, and in 1900 a large new factory was built at the corner of Normanby Road and Montague Street, South Melbourne, where operations are still being carried on.

Fierce competition having arisen in the Australian nail and barbed wire trade, it was deemed wise to form all existing local manufacturers into a co-operative selling agency, called the Southern Star Nail & Wire Pty. Ltd. Of this combination, which continued in existence until 1923, the Titan Co. was one of the principal members.

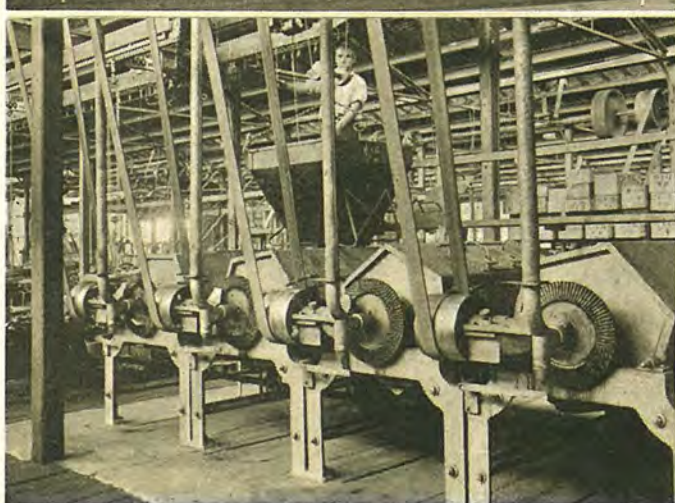
The death in 1921 of John Rose led to the birth of the Titan Manufacturing Co. Ltd., the management of which was assumed by Walter Rose, son of the deceased founder. The new business added shovels to its list of products, the manufacture of which it also pioneered in Australia.

Up to the outbreak of the war all raw materials necessary to the industry were imported, but the commencement of production, particularly of wire, at Newcastle, led to a profound alteration in the position as regards the manufacture of wire products.

To meet these changed conditions, the nail, barbed wire and other wire product sections of the business were sold to a new company, the Titan Nail & Wire Pty. Ltd., incorporated on January 8, 1927. Half the shares in this new organisation were retained by the Titan Manufacturing Co. Pty. Ltd., and the remaining half were taken up by The Broken Hill Pty. Co. Ltd. The sheet metal side of the industry was gradually liquidated, operations in this line finally ceasing in 1931.

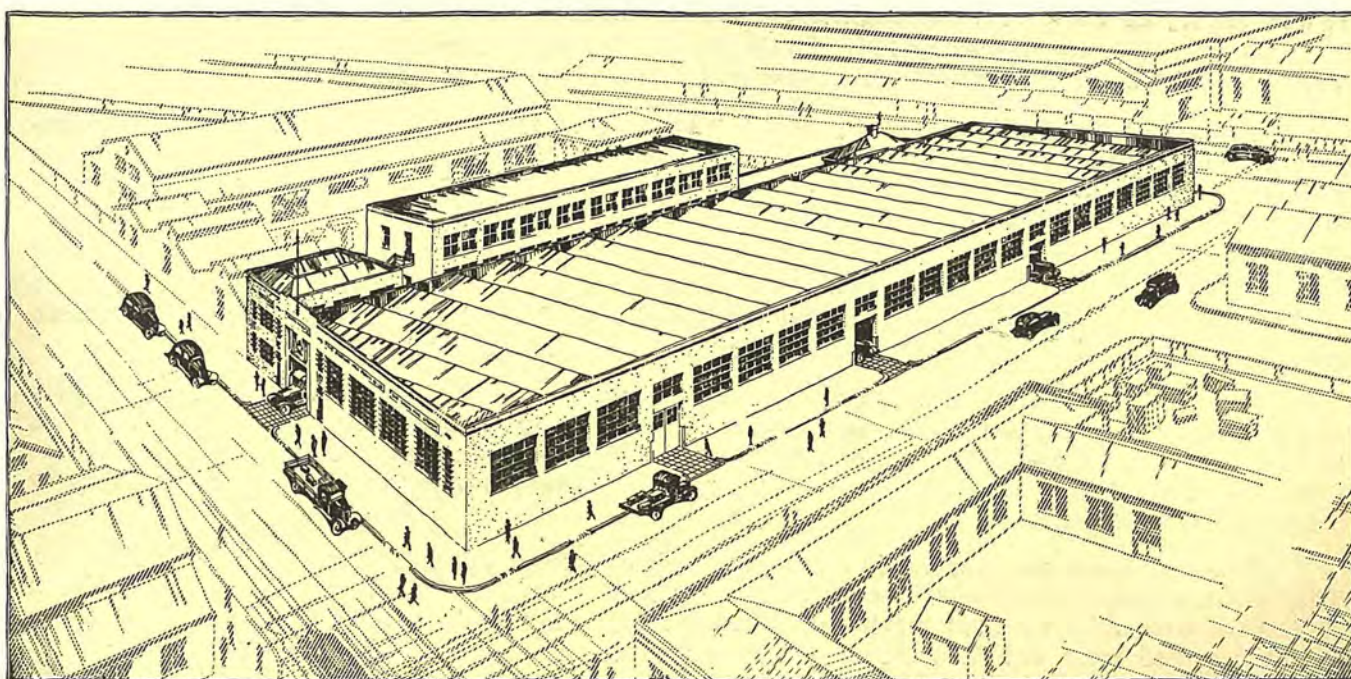
In February, 1933, the half share in the business which had been retained by the Titan Manufacturing Co. Pty. Ltd., was purchased by The Broken Hill Pty. Co. Ltd., and Walter Rose retired from the management. The company then set out to modernise its plant. At the present time it is operating probably one of the best equipped and most up-to-date plants of its kind in the Commonwealth, the capacity being approximately 200 tons per month.

In pursuance of the progressive policy which has marked the Company's history, a specially designed up-to-date factory is now being erected in South Melbourne. The site (over an acre in area) to which the Company's comprehensive plant will be transferred, is bounded on three sides by Ferrars, Lorimer, and Normanby Streets.



Top left: General View of Barbed Wire Store.
Bottom left: A Battery of Polishing Rumbler.

Top right: Weighing and Casing Nails.
Bottom right: A Barbed Wire Machine in Operation.

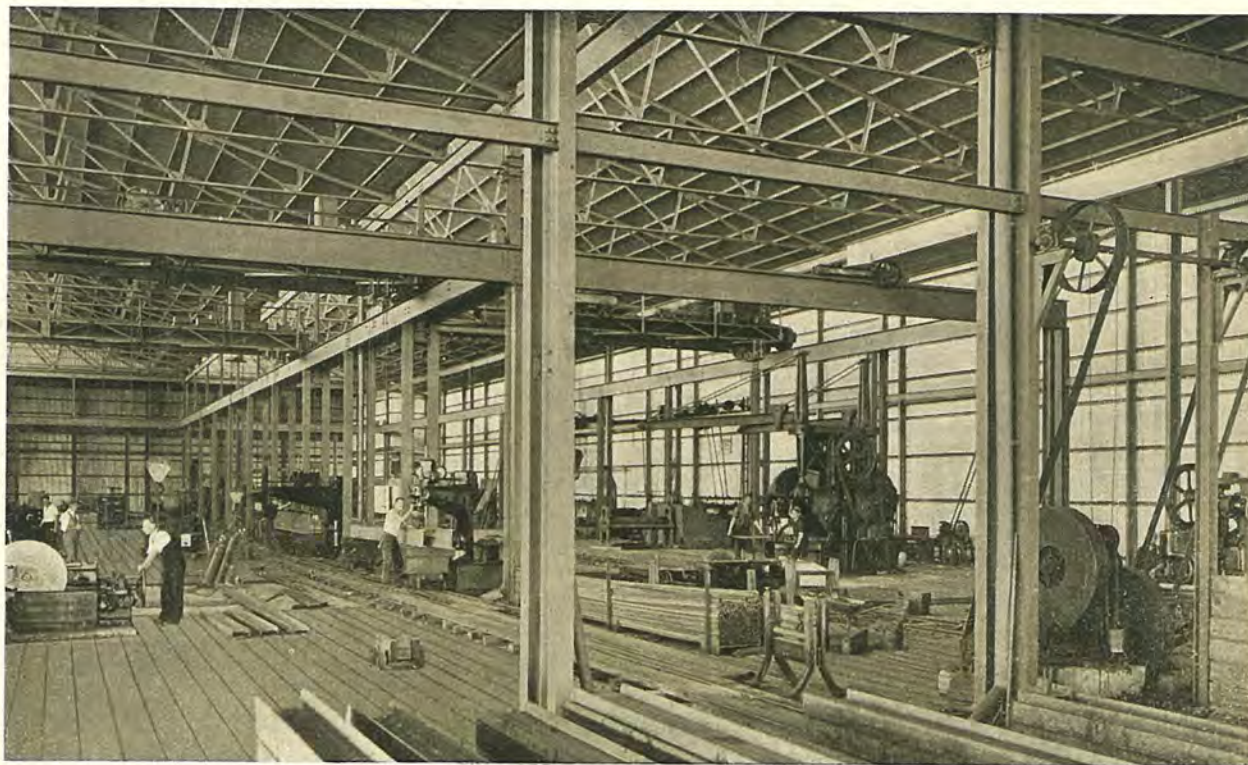


NEW PREMISES OF THE TITAN NAIL AND WIRE PTY. LTD., SOUTH MELBOURNE, VICTORIA.



The Structural Engineering Co. of W.A. Limited

WELSHPOOL, PERTH, W.A.



FABRICATING SHOP.

THE history of The Structural Engineering Co. of W.A. Limited may be traced back to the fabrication of 3,000 tons of steel by Elder Smith & Co. Ltd. for the General Post Office in the year 1918. This was built by the Commonwealth Government in Forrest Place, Perth.

From that time onwards rapid progress was made by these engineering shops, and many important steel and reinforced concrete constructions were successfully carried out. During the latter part of the year 1928 it was necessary, owing to increased volume of business, to purchase more modern plant and machinery. A new company in which the B.H.P. is largely interested was incorporated in 1929 to take over the steel department of Elder Smith & Co. Limited, and commenced operations on the 1st January of that year.

The company built and equipped the most modern and spacious fabricating shops in Western Australia, access being provided by both road and private railway siding.

The works, which are situated at Welshpool, six miles from Perth, were designed, fabricated, and erected by the staff of the company. The latest high speed electrically driven plant was installed, including two 15-ton and two 5-ton cranes. The electric power for this plant is obtained from the Government Electricity Department, and is conveyed through underground high tension lines to the works' transformers.

The workshops are laid out in an 8-acre block and cover an area of approximately $2\frac{1}{2}$ acres. They are laid down with 2 inch wooden floors over a concrete foundation. The lay-out provides a continuous straight line for the moving of steel in course of fabrication from the stock shed to the despatch bay, and every care has been taken to ensure that further extensions to the works could be made without disorganisation of any work in progress. The capacity of the works under normal conditions is about 300 tons of fabricated steel per month.

ADMINISTRATIVE PERSONNEL



1935

THE BROKEN HILL PROPRIETARY CO. LTD.
SUBSIDIARY AND ALLIED INDUSTRIES



THE BROKEN HILL PROPRIETARY CO. LTD. BOARD OF DIRECTORS, 1935.

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Back Row—left to right: F. M. Mitchell (Secretary), Hon. W. G. Duncan, M.L.C., Essington Lewis (Managing Director), R. C. Meares.

Administrative Personnel.



H. G. DARLING

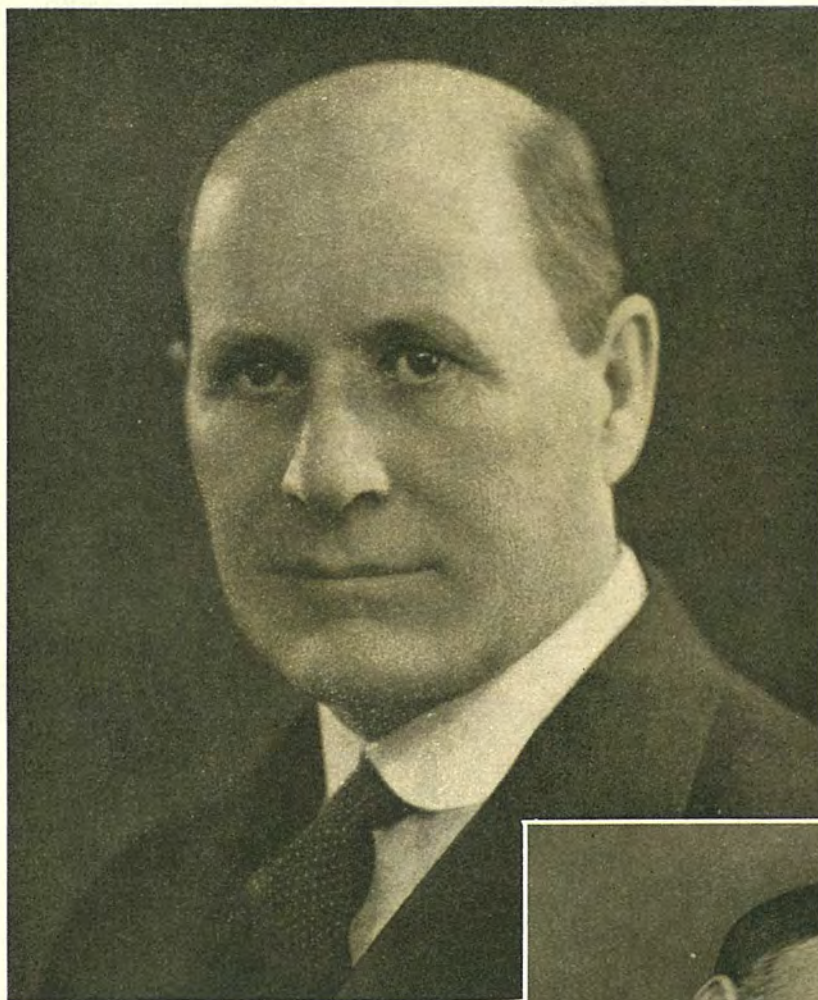
Chairman of Directors
of
The Broken Hill Proprietary
Co. Ltd.



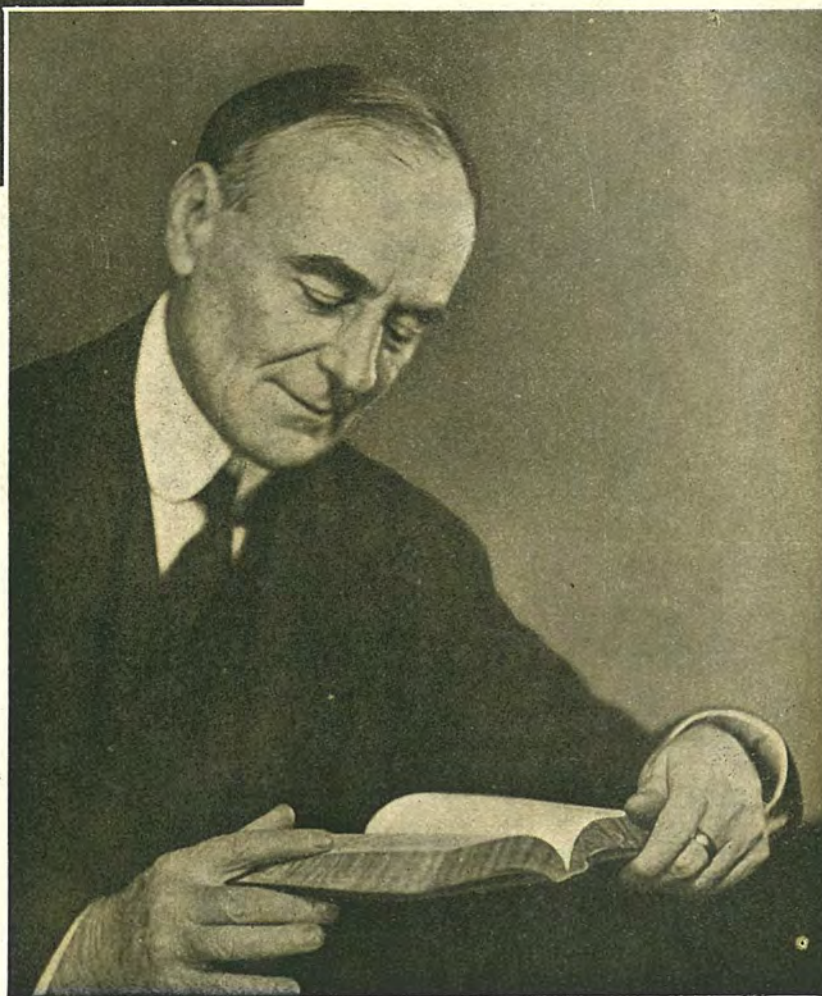
ESSINGTON LEWIS

Managing Director
of
The Broken Hill Proprietary
Co. Ltd.

Administrative Personnel.

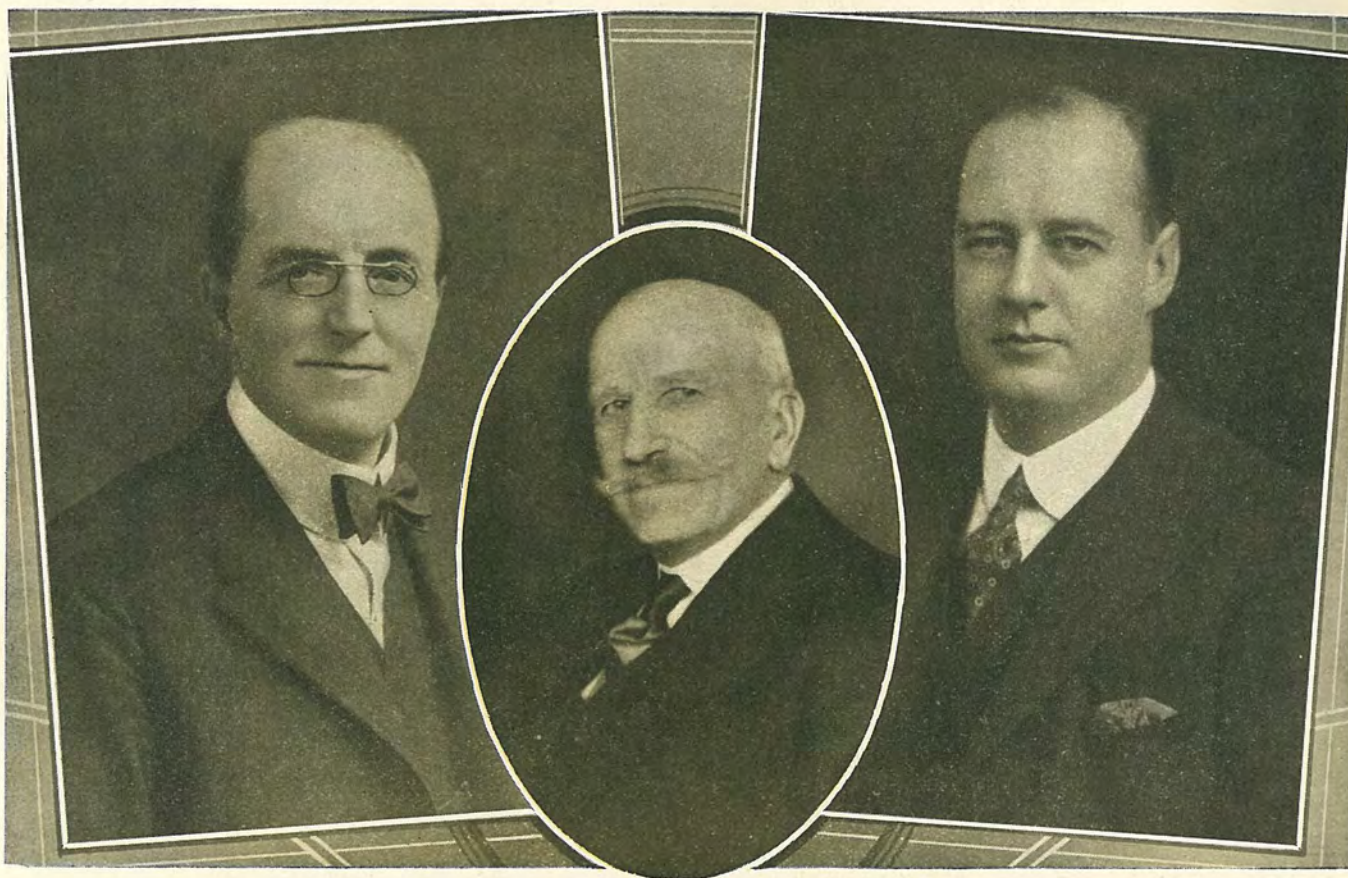


L. BRADFORD
General Manager
of
The Broken Hill Proprietary
Co. Ltd.



F. M. MITCHELL
Secretary
of
The Broken Hill Proprietary
Co. Ltd.

Administrative Personnel.



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Sir W. Peter Rylands (Chairman), Mr. W. R. Lysaght, O.B.E., Mr. Leonard Darling.



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Insets.—Top Row (left to right)—F. R. Hockey (General Supt. of Mines and Quarries), Dr. R. L. Jack (Mining Geologist), V. C. Eddy, C. L. M. Templeton (Legal), S. A. R. Evans, Miss D. Gates.

Second Row—A. Q. McCutcheon, D. M. Frankenberg, G. Sutherland, G. W. Selby (Auditor). Bottom Row—G. Hansen, Miss G. McKellan.

SECOND ROW (left to right)—G. Bullen, J. O. Wilshaw (Manager, Titan Co.), A. E. Williams, H. Wilson, D. Thomson (Manager, Stewarts and Lloyds), E. R. Halse, J. F. Mackie, W. R. Coles, J. B. Swan (Asst. Secretary), E. J. Horwood (Supt. of Mines), F. M. Mitchell (Secretary), Essington Lewis (Managing Director), J. R. Barter (Shipping Manager), R. H. M. Rowe (General Sales Manager), C. Pratt (Accountant), W. A. Robinson (Asst. Secretary, Rylands), H. P. Wright, J. Menzies, I. W. Carpenter, A. G. Brown, T. R. Longney, W. V. Fowler, G. H. Bishop.

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Administrative Personnel.



THE BROKEN HILL PROPRIETARY CO. LTD., STEEL WORKS NEWCASTLE ADMINISTRATIVE STAFF, 1935.



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38. W. S. A. Tayler.
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40. S. Flowers.
(Mgr. John Darling Coll.).
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42. W. Mendenhall.
43. H. Mitchell.
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45. R. L. Carr.

46. C. Cox.
47. A. Dalziel.
48. R. G. Newton.
49. E. T. Henderson.
50. E. Guy Smith.
51. L. B. Lindemuth
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(Gen. Supt. Rolling Mills).
53. J. J. Jeffries
(Supt. Collieries).
54. L. Grant
(Assistant Manager).
55. L. J. Griffiths
(Manager).
56. K. Butler
(Actg. Production Supt.).
57. A. K. Hacke
(Chief Eng. to Coy.).
58. T. A. Griffiths.
59. David Baker, junr.
(American Agent B.H.P.).
60. T. Hale.
61. L. P. Ross
(Consulting Engineer Iron
Production).

62. E. S. Anderson.
63. J. R. Young.

INSETS.

Left to Right, Top Row:—
L. Bradford
(General Manager).

F. Affleck.
(Asst. Works Sec.).
A. J. L. Bailey
(Sales Mng., N.S.W.).
G. Brown.
K. Church.
R. Colquhoun.
L. Forde.

Bottom Row:—
A. V. Hunt.
N. E. Jones.
A. Kinley.
L. P. Sibley
(Mgr. B.H.P. By-Prod.).
W. Power
(Master Mechanic).
J. S. Swainson
(Works Secretary).
E. Howell.

Administrative Personnel.



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Administrative Personnel.



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Back Row—H. J. Mitchell, G. D. Brown, G. R. Glasson, Miss Y. M. Yeomans, H. W. Ochnal, R. M. Cowham, C. M. Rogers, N. B. Glover.



THE BROKEN HILL PROPRIETARY CO. LTD. PERTH STAFF, 1935.

Back Row (left to right)—R. W. Redfern, H. C. Watson, S. G. Bell (Manager), J. H. Davies.
Front Row (left to right)—Misses E. McKimmie, F. Musakahn, J. Stewart, O. Wilson.

Administrative Personnel.



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Administrative Personnel.



THE BROKEN HILL PROPRIETARY CO. LTD. IRON KNOB STAFF, 1935.

Back Row (left to right)—R. C. Gray, M. Sheridan, J. H. Kittel, D. Edgar, T. Kersten. Front Row (left to right)—J. C. London, D. M. Lombard (Officer-in-Charge), H. J. Lugg, R. Smith. Insets (left to right)—L. R. Easton, N. V. Potts, R. A. Barnard.



THE BROKEN HILL PROPRIETARY CO. LTD. HANNAN'S NORTH STAFF, 1935.

Standing (left to right)—H. E. Edwards, H. C. Chappell, J. L. Toy. Sitting (left to right)—Bain Hogg, Miss Burton, R. G. Collins (Manager), J. O. Milne.

Administrative Personnel.



THE BROKEN HILL PROPRIETARY CO. LTD. MELROSE (TAS.) QUARRY STAFF, 1935.

Left to right: E. W. McKendrick, P. C. Ryan, P. F. Moore (Acting Supt.), J. W. Sutton, J. M. Breden



THE BROKEN HILL PROPRIETARY CO. LTD. BROKEN HILL STAFF, 1926.

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Administrative Personnel.



RYLANDS NEWCASTLE STAFF, 1935.



— KEY —

- | | | | | | |
|----------------------|--------------------|-------------------|--------------------|-------------------|---|
| 1. N. Leishman. | 19. N. Towns. | 37. J. Wade. | 54. M. Fletcher. | 72. H. Lewis. | 90. G. Smith. |
| 2. W. Rutherford. | 20. L. Eagan. | 38. H. Matthews. | 55. S. Roe. | 73. F. Guy. | 91. C. Green. |
| 3. Miss M. Morgan. | 21. F. Cave. | 39. E. Atkinson. | 56. H. Blaze. | 74. E. Merrick. | 92. W. Andrews. |
| 4. Miss N. Williams. | 22. R. Dean. | 40. H. Coates. | 57. A. Kemps. | 75. T. Robson. | 93. H. Hargreaves. |
| 5. Miss J. Telfer. | 23. F. Stewart. | 41. J. Astbury. | 58. F. Goodman. | 76. T. Boyd. | 94. C. Shipway. |
| 6. Miss M. Hawcroft. | 24. M. Ewing. | 42. G. Morgan. | 59. J. Skinner. | 77. E. Walker. | 95. P. Faulk
(Mill Supt.). |
| 7. Miss B. Whitford. | 25. A. Geary. | 43. R. Stauffer. | 60. C. James. | 78. R. Lister. | 96. M. Caro. |
| 8. Mrs. O. Wallwark. | 26. T. Dodd. | 44. A. Gatiss. | 61. J. Walker. | 79. R. Humphries. | 97. W. Lang
(Engineer). |
| 9. Miss E. Jones. | 27. C. Long. | 45. J. Wells. | 62. J. Still. | 80. L. Negus. | 98. F. McCook
(Accountant). |
| 10. Miss B. Beattie. | 28. A. Hartcher. | 46. P. Joyce. | 63. A. P. Travers. | 81. L. Hillyard. | 99. J. K. MacDougall
(Manager). |
| 11. Miss M. Farmer. | 29. A. McCann. | 47. F. Welshman. | 64. A. Shaw. | 82. H. Milne. | 100. M. Howarth
(Assistant Manager). |
| 12. Miss I. Deamer. | 30. C. Millington. | 47a. C. Crosslan. | 65. S. Waters. | 83. G. Simpson. | 101. A. Wark. |
| 13. Miss J. Kelly. | 31. G. Henderson. | 48. J. Whitehead. | 66. F. Cooper. | 84. W. Porter. | 102. F. Jenks. |
| 14. Miss M. Uren. | 32. A. Irwin. | 49. P. James. | 67. F. Terry. | 85. H. Perkins. | 103. G. Edwards. |
| 15. A. Coulton. | 33. A. Walls. | 50. E. Brennan. | 68. T. Williams. | 86. P. Page. | |
| 16. A. Stratford. | 34. S. Dunstan. | 51. L. Smith. | 69. A. Lever. | 87. A. Inman. | |
| 17. N. Hetherington. | 35. J. Jones. | 52. W. Hatton. | 70. H. Jones. | 88. G. Garside. | |
| 18. J. Hampton. | 36. W. Gray. | 53. F. Hall. | 71. T. Bloomfield. | 89. T. McKenzie. | |



LYSAGHT'S NEWCASTLE WORKS STAFF, 1935.

Back Row (left to right)—H. F. McInnes, E. A. Livsey, J. Hawkins, J. C. Campbell, G. E. Crossman, A. Robertson, H. Brunt.
Front Row (left to right)—A. Bear, V. A. Wardell, P. K. Parbury (Mill Supt.), R. Parry Okeden (Manager),
E. B. Hill (Galv. Supt.), E. J. Simpson, R. Murphy.



STEWARTS AND LLOYDS NEWCASTLE STAFF, 1935.

Front Row (left to right)—A. N. Hamilton (Works Manager), P. W. A. Wood (Managing Director), J. A. B. Reid (Works Director).
Back Row (left to right)—L. Smalley, J. Miller, R. Gibb (Secretary).



COMMONWEALTH STEEL COMPANY LTD., NEWCASTLE STAFF, 1935.

Back Row (left to right)—W. Wallace, C. Trelease, L. Abel, J. Anchau, W. Eddy, S. Clegg, W. Jackson, J. Hutchins, C. Cletcher.
Front Row (left to right)—E. Hosie, W. Sutherland, F. Edwards, W. E. Clegg (General Manager),
W. Frankham (Works Manager), D. Clark, K. Donald, T. Smith.



AUSTRALIAN WIRE ROPE WORKS LTD., NEWCASTLE STAFF, 1935.

Back Row (left to right)—P. Edwards, G. Ross, R. Richards. Front Row (left to right)—H. S. Morris, E. King (Managing Director), H. Neave.



ELRINGTON COLLIERY STAFF, 1935.

Front Row (left to right)—G. Bennett, R. F. Doyle, S. McKenney (Supt. Collieries), G. M. Hindmarsh (Manager), J. Owen, W. Wilkie.
Back Row (left to right)—F. N. White, G. Stewart, L. Penniment, L. Waples, T. Bruce, J. Anderson, W. Jackson.



STRUCTURAL ENGINEERING CO. OF W.A. LTD. STAFF, 1935.

Back Row (left to right)—C. L. Agg, L. J. Herlihy, E. H. Sturrock. Front Row (left to right)—J. R. Carden, Miss A. Milno, Miss H. Cartwright, C. H. Jensen. Inset—J. Hamilton (Manager).



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