However, it should be noted that to-day none of the Royal Ordnance Factories is engaged exclusively in civil production. Each is turning out its appointed quota of military potential.

Fazakerley's civil production has been confined chiefly to the manufacture of petrol-engines, of the general utility type long made familiar by the firm of Petters, of Yeovil.

Work suffered comparatively little from enemy action during the war. The local cemetery was bombed once or twice by the Luftwaffe, with what can only be described as misdirected enthusiasm, but the Factory itself got off with some incendiaries, which were promptly and efficiently dealt with by the A.R.P. staff.

R.O.F. - THE STORY OF THE ROYAL ORDINANCE FACTORIES - 1939-1948 IAN HAY. HMSO 1949.

CHAPTER SEVEN

PEMBREY

We proceed now from the manufacture of the weapons of war to that of the explosives with which they are charged, from specifications based mainly, as usual, upon the experience gained by research at the Royal Arsenal, the Royal Gunpowder Factory at Waltham, and the Royal Ordnance Factory at Irvine, in Ayrshire.

The work is carried out in two distinct types of factory, the Explosives and the Filling Factory. The one provides the explosive material, the other encases it in its appropriate receptacle. The two operations are never carried out in the same factory.

The outstanding products of the Explosives Factories were tri-nitro-toluol (T.N.T.), the powerful high-explosive employed in the detonation and fragmentation of shells and bombs; and cordite, the propellant used to discharge the shell from the gun. To these should be added the newer and tremendously violent explosive known as R.D.X., which was used in 'blockbuster' bombs, and also employed, in suitable form, for demolitions, field-work, and sabotage, where the adventitious aid of shell-splinters was neither needed nor welcomed.

T.N.T. was manufactured at four R.O.F.s—namely, Pembrey, Irvine, Drigg, and Sellafield. The great factory at Bishopton, in Renfrewshire, was the principal source of cordite, and also produced

tetryl and R.D.X. During the war the eight factories among them produced some three-quarter million tons of explosive material.[1]

Let us now pay a visit to Pembrey, in Carmarthenshire, whence our largest supply of T.N.T., tetryl, and ammonium nitrate emanated.

The village of Pembrey lies on one of the loveliest stretches of the South Wales coast, midway between Llanelly and Kidwelly. The Factory buildings are spread over some 500 acres of dune and sandhill, which furnish at once an effective screen and a safeguard against widespread damage in the event of an explosion. Consequently but little of the Factory itself is visible to the passer-by, though its existence and activities are kept in evidence night and day, first by reason of the yellowish nitrous fumes discharged from its tall chimneys, and secondly by the occasional smoke and glare of burning T.N.T., extracted from bombs and shells no longer fit for service.

A bird's-eye view of the whole area would show the central offices, police barracks, canteen, surgery, library, and administrative buildings in general grouped closely together at one end, with the nitration buildings, magazines, and other danger-spots widely scattered. Roadways, capable of accommodating motor traffic—the most imposing is known as Burma Road—provide the necessary lines of communication.

The R.O.F., Pembrey, is of no mushroom growth. It was originally owned and operated by the great firm of Nobel, but was taken over by the War Office in 1914. In the interval between the two world wars the Factory fell into disuse, but served a worthy purpose during the years of depression as a convalescent home and rehabilitation centre for the children of the unemployed miners of South Wales.

With the approach of the Second World War the Factory was once more taken over, reconditioned, and largely rebuilt. Production began in December 1939. To-day the whole area is enclosed by a high boundary fence, and that most efficient body, the War Department Constabulary, see to it that no unauthorised visitor penetrates its mysteries. In any case, matches, tobacco, pipes, and the like must be left at the gates, and articles of food deposited forthwith at the canteen.

The last regulation is based on the fact that certain foodstuffs—sugar, for instance—are capable of entering too readily into chemical combination with some of the reagents employed in the manufacture of explosives. I was even told of an employee who once, by an untimely cough, discharged a half-masticated toffee-drop into a pan, with pyrotechnic results. The only place where it is permitted to smoke is in the canteen. Here cigarettes, to be consumed on the premises, can be purchased from a species of bonded store. Since no matches

[1] These were 'short' tons, reckoned at 2,000 lb. to the ton. The ordinary ton is 2,240 lb.

are permitted, the cigarettes are ignited by an electric contrivance similar to those fitted in the more expensive type of motor-car.

The Factory to-day employs 1,300 people, of whom about 50 are women. Its full strength during the war was 3,000. The men had previously been employed in the coal-mining and tin-plate industries of the district, but long years of enforced idleness and semi-starvation had rendered their physical and mental rehabilitation a problem which called for time, tact, and patience. In the first place they had to be instructed in the safe handling of explosive material and in the avoidance of the inhalation of noxious fumes. The handling of nitro compounds such as T.N.T. is likely to lead to dermatitis, and this is especially so in the case of tetryl; and in the manufacture of such a powerful explosive it was a case of 'No blondes need apply'. The pigmentation of the skin is the deciding factor here, and only dark-haired or swarthy individuals can safely be engaged in the work.

Each man had to be trained, too, in his particular duties. Here valuable aid was rendered by the application of the principles laid down by the Institute of Industrial Psychology, especially in the selection of the right man for the right job.

Every Royal Ordnance Factory, needless to say, requires an administrative staff, under a Superintendent and Principal Clerk. At Pembrey, unlikely as it may appear, the Superintendent is an Englishman and the Principal Clerk a Scot. To correct any misapprehension, however, as to the soil upon which he stands, the casual visitor will find himself, upon entering the Central Building, confronted on the very threshold by the Welsh coat-of-arms, with the proud motto 'Cymru Am Byth!' (Wales for ever!) emblazoned on the wall beneath it.

The Central Building itself, once a dormitory for the unemployed miners' children, consists of a pleasant pillared hall, decorated in cream and green, which affords access to the principal offices, either from the ground floor itself or from a gallery running round above. The offices are unusually airy and well-lit, and care has been taken to relegate those disturbing instruments, the typewriter, the calculating machine, and the teleprinter, to a fastness of their own, in order to enable the planners and brainworkers to conduct their deliberations in peace.

In one of these offices, the Wages Branch, I noticed that that troublesome coin the halfpenny was dealt with just as faithfully as but more expeditiously than the farthings in old days at Woolwich. At Pembrey every odd halfpenny is ignored one week-end and carried forward to the next, there to combine with another halfpenny to form a complete and accountable penny.

The actual output of Pembrey R.O.F. to-day is divided, as has become the almost universal practice, between war potential and some sort of civil product which can be manufactured with but slight adaptation—in some cases no adaptation at all—of existing machinery.

The principal warlike products are T.N.T. and tetryl. On the side of the arts of peace we have ammonium nitrate, invaluable to-day as an agricultural fertiliser. The possibility of manufacturing other fertilisers is being examined.

We will begin with T.N.T. The chemical process employed is somewhat involved, and it will be best here to describe it from the point of view of the interested spectator rather than that of the scientific expert. Let it suffice to say that T.N.T. is manufactured by treating with nitric acid a substance known as mono-nitro-toluene, this substance having been made at a previous stage by the action of nitric acid on toluene (a derivative of coal-tar).

Let us therefore imagine that we are in the Nitration Building, contemplating a long row of so-called nitration pots, in which the acid and the mono-nitro-toluene—described hereafter for convenience as the nitro-body—are to be brought together. The process is not without risk, as we have gathered from a notice-board outside the entrance, which states precisely how many operators and how much material may be introduced into the building at one time. For the same reason the process is divided into a series of separate operations: that is why there are 16 nitration pots in the row. These are vats about 4 feet high standing on a level floor, and are made either of lead or cast-iron, neither of which is affected by the corrosive action of acids used.

The essential feature of the process is that it is continuous. The nitro-body is fed into pot 1, and passes through the remaining 15 pots to flow continuously from pot 16 as Trinitrotoluene—T.N.T. The nitric acid necessary for this transformation is introduced into several pots along the row.

In the action of the nitric acid on the nitro-body water is formed and must be removed, otherwise the concentration of the nitric acid would be reduced and the action slowed down or stopped altogether. To absorb this water so as to allow full play for the nitric acid, sulphuric acid, which has an affinity for water, is caused to flow in the reverse direction from pot 16 to pot 1; so the whole process becomes a continuous counter-current operation, the nitro-body flowing in one direction and the acids in the opposite direction.

Each nitrating pot is lined with coils of piping, through which hot or cold water can be passed to control the temperature, and is fitted with a stirrer (a swiftly revolving vertical paddle) to bring about intimate mixing of the acid and the nitro-body.

Now we must look a little more closely and appreciate the ingenious manner in which the ingredients of these intimate mixtures are separated at each pot and caused to flow in opposite directions. Into each pot fits an archimedean screw lift which continuously lifts the mixture from each nitrating pot to shallow vessels, one to each pot, placed at the back and slightly above each pot. These vessels are known as separators. In the separators, which are unstirred, the acids (being heavier) sink to the bottom and the nitro-body floats on top. By means of weirs in each separator, the ingredients of the nitration pot, thus separated, can be conducted in different directions. If then we look at, say, pot 8, the nitro-body overflows along a gutter to nitration pot 9 for further nitration, and the acids flow along another (and lower) gutter to pot 7: and this is the manner by which the transfer is arranged at each pot.

By the time the acid mixture reaches pot 1 it is known as spent acid. It consists in the main of sulphuric acid diluted by the amount of water absorbed from the reaction. It is recovered, reconcentrated in special plant and used again and again.

Perhaps the most important instrument in the Nitration Building is the thermometer; for if the temperature rises suddenly, and above a certain point, at any pot, something is wrong—seriously wrong—and immediate action is called for. If this happens, an emergency apparatus is set in motion, which promptly drains the entire contents of the overheated pot into a deep water-tank outside the building. In the case of imminent and general danger, all sixteen pots can be emptied at once by the operation of a single lever.

The T.N.T., now a viscous yellow fluid, has next to be passed through various purification processes and then to be cooled and solidified. This is effected by running it over water-cooled phosphor bronze drums until it has hardened, and it is then scraped off. The T.N.T. falls away in flakes and is packed in bags and boxes and dispatched to a Filling Factory.

Some of these bags, when they have served their turn, are transformed into an interesting and unusual by-product. They are packed, after decontamination in the laundry, and dispatched to a commercial firm in the south of England which converts them into the paper from which banknotes are made—not English banknotes, incidentally.

* * *

We proceed next to the study of the method by which ammonium nitrate is produced. For this we will pay a visit to the West Factory. Here again we have an opportunity to note the conversion of an

Ordnance Factory to peace-time uses. The ammonium nitrate which we are about to see manufactured and which, mixed with T.N.T., gives the explosive filling called amatol, used in shells and bombs, will mainly be employed as an agricultural fertiliser.

Ammonium nitrate is a white crystalline substance, soluble in water, and is produced by treating ammonia with dilute nitric acid. The resulting product is a mixture of ammonium nitrate and water. The next step is to separate the ammonium nitrate from the water in which it is dissolved: most of the water is removed in the neutraliser, the vessel in which the ammonia is added to the dilute nitric acid, and then in an evaporator.

This gives a slurry, from which the ammonium nitrate is separated by the employment of that invaluable aid to mechanical effort, centrifugal force. To this end the slurry is whirled round inside a circular container, with the result that solid ammonium nitrate is deposited all round the interior, while the water drops back into the sump below.

The ammonium nitrate is now scraped off the inside of the container and passed successively through two great boiler-like chambers known as the drier and the cooler. Passage through these vessels brings the nitrate down to the lower floor of the building, whence it is raised once more, this time by the employment of a screw-conveyor, to the upper floor, whence it descends, once more by gravity, into an apparatus called a beater, which breaks up any lumps or cakes which may have formed. On its way up, incidentally, it passes close to a powerful electro-magnet, which draws from it any ferrous impurities.

The complete product is now ready to be packed into air-tight steel drums. The drums are already sealed, except for an opening on the top of each, into which the nose of the hopper from which the nitrate crystals are descending fits closely.

On top of the drum in the hopper arrangement the visitor may observe another opening, a very small one this time, over which a celluloid ball, of the ordinary ping-pong variety, enclosed in a tiny wire cage, is bobbing vigorously up and down. Its function is to indicate the moment at which the drum has become full. So long as the filling is in progress, the air inside the drum will be expelled through the small opening, thereby keeping the imprisoned ping-pong ball continually agitated. With the drum full, there is no more air to be expelled, and the ball comes to rest. This ingenious little device was the invention of a worker actually employed in the West Factory. For it he received a well-deserved gratuity of £100.

The steel drums into which the nitrate is packed stand about 3 feet high, and are all manufactured within the Factory itself. At the peak of production they were being turned out at the rate of over 1,000 a day. The work is done by women, and a most impressive

and high-speed exhibition of mass-production they make of it. The process of constructing the drums is, in a sense, the exact reverse of that which we saw employed at Woolwich Arsenal to flatten out the Anderson shelters into sheet-steel. In this instance we start with the sheet-steel, then bend it round into cylindrical shape, then weld the edges together, then impose certain horizontal corrugations to impart the necessary rigidity, then fit on the base, and the drum is completed.

The process of construction is divided up, as usual in progressive mass-production, among a series of machines operated, with the utmost speed and concentration, by a corps of young Amazons in overalls and coloured turbans. Their aim appears to be perpetual motion, and except for the periodic and statutory pause for a cup of tea, they achieve it. It is an exacting job, and a grimy one—the spray-painting of the completed drum in particular—but to see these girls climbing on to the waiting buses outside the gate at the end of the day, there is nothing either in their smart little frocks or their becoming make-up to distinguish them from their more softly employed sisters of the Central Building.

* * *

To-day, besides creating munitions of war, our Royal Ordnance Factories are busily employed at the same time in destroying them. At Pembrey large quantities of superfluous or obsolete ammunition are being broken up, or rather down, and the process has been continuing since 1944. During 1945–46 more than 200,000 4·5-inch anti-aircraft shells were so treated and returned to the melting pot, the explosive which they contained having first been removed.

In the breaking-down plant at Pembrey, I watched a number of 500-lb. bombs, of the type rather prosaically described as G.P., or general purpose, undergoing such treatment.

First of all they had to be emptied of their load of T.N.T. To effect this it was necessary to extract the stopper ('booster-plug'), which is screwed tightly into the neck of the bomb. To facilitate the operation the plug was softened-up by the application of steam, after which it was removed, exposing to view the solid core of T.N.T. within.

The bomb was now ready to be washed out. For this purpose a number of water-jets projected from the floor of the building, capable, upon being turned on, of shooting a stream of boiling water right up to the roof. Over each of these one of the de-plugged bombs was carefully lowered, the neck of the bomb fitting fairly closely over the jet. The boiling water was then turned full on. The effect was

soon noticeable, in the form of a pea-soup-like mixture of T.N.T. and water oozing from the neck of the inverted bomb and escaping along a gutter to the regions below. The process in each case was continued for an hour and a half, after which the empty shell of the bomb was hoisted up and handed over to a uniformed Inspecting Officer, representing one of the three Services,[1] whose responsibility it was to examine the interior and pronounce sentence on whether it was to be retained or scrapped. The interior was then dried, and the empty bomb sent either to store or to a foundry.

Meanwhile, in the chamber below, the descending stream of water and T.N.T. was being separated, and the T.N.T., still in a molten state, was run off into a series of containers each holding about 1,000 lb. Finally the containers were trundled off to participate in the last scene of all, on the Burning Ground—a desolate patch of sand-dune well removed from proximity with any of the buildings. Here the T.N.T. was dumped, allowed to solidify, and electrically ignited. There was no explosion—T.N.T. requires tight packing for that—only a roaring bonfire of hot red flame and dense black smoke. Even to one standing fifty yards up-wind the heat was almost overpowering.

The density of the smoke was caused by the presence of large quantities of oily soot, or 'carbon-black', released by the action of the air upon the toluene content of the T.N.T. Carbon of this kind is exceedingly valuable for commercial purposes, such as the manufacture of printer's ink, and at Pembrey a certain proportion of the waste T.N.T. is specially treated for its production.

The method of treatment is simple and ingenious. A series of circular iron pans, about the size of an ordinary wash-hand basin, are filled with lumps of broken T.N.T., upon which have been laid a few sticks of cordite. A jet of flame is played for a moment or two upon each pan: this ignites the cordite, which in its turn sets off the T.N.T. The pan and its fiercely blazing contents are then slid under a chimney-like structure some 20 feet high, in which an upward draught is being created by a swiftly revolving fan, which draws the mixture of gases and smoke into a container or 'cyclone' in which they are whirled violently round, with the result that the carbon-black is deposited in a thick layer round the inside of the container.

Not quite all of it, though: the surrounding atmosphere is soon filled with invisible particles of so-called free carbon, as the casual spectator will discover for himself when next he contemplates his own features in a mirror. No, the manufacture of carbon-black cannot by any stretch of imagination be described as a white-collar industry.

[1] These represented the C.I.A. (Chief Inspector of Armaments), the I.N.O. (Inspector of Naval Ordnance), and the A.I.D. (Aeronautical Inspection Department), respectively.

It remains to make a brief survey of Pembrey's less belligerent activities. One of the most unusual and interesting of these is the drying of grass by a special process, without, as it were, turning it into hay. Grass so treated is rich in protein and carotin, and is of particular value to breeders of pedigree cattle, especially where the process of artificial insemination has been employed. Its value is double that of hay, and it can be delivered either in bales, or powdered into so-called grass-meal.

Laundry-work must always be a special feature of an explosives factory, for all working-attire must be kept scrupulously clear of grit and dust: in fact, a worker should find a clean outfit awaiting him at every shift. So extensive is the laundry plant at Pembrey that it can afford to indulge in the highly altruistic occupation of taking in other people's washing—from the R.A.F., Demobilisation Centres, and Prisoners of War camps. No private customers, however, need apply.

Mention of laundry-work brings us to the question of ablution in general—and ablution in an establishment such as Pembrey, where workers are likely to be in contact with nitro-compounds, falls practically under the heading of Medical Service, for every precaution must be taken against the possibility of dermatitis and other affections of the skin. A special creamy preparation is issued to prevent this. Bathing facilities are abundant, and even include a hot-air drier. Sun-ray treatment is available to all.

But perhaps among all the responsibilities of R.O.F. administration transport and catering rank highest. At the end of each shift at Pembrey crowded motor-vehicles, conveying workers from outlying buildings, begin to arrive at the main gate, where their passengers transfer themselves to a long queue of motor omnibuses waiting outside, to convey them to towns and villages as far away as 30 miles.

To realise the scope and magnitude of the catering services we have only to pay a visit to the canteen, about the hour of noon. It is a vast, well-lit and airy hall, filled with long tables whose occupants are enjoying a substantial three-course dinner which has cost them exactly tenpence. At one end is a long open counter, across which girls in a becoming green uniform are handing out the dishes, straight from the kitchen and piping hot.

At the other end is a stage, equipped with a highly decorative proscenium, in frequent demand for theatrical and other entertainment. Round the walls hang numerous oil-paintings and sketches, mostly depicting the Carmarthenshire coast and other beauties of Welsh scenery. They are all the work of a single hand—as is the stage-proscenium and the 'interior set' which it frames—the hand of an employee of the Factory. He is self-taught, and every moment of his spare time is devoted to his hobby. His equipment is of the simplest: many of his pictures are painted on odd squares of sail-cloth. But each one of them is a work of art.

* * *

Of danger from without Pembrey has had one grim experience, in the shape of a raid by a lone German flier, in broad daylight on July 12th, 1940. The pilot dropped his first bomb just inside the main gate of the Factory—you can still see the splinter-marks on the adjacent buildings—and then proceeded upon a deliberately ordered course. His second bomb fell near the Canteen. He then wove a course which included certain vitally important and vulnerable buildings. Casualties numbered 11 killed and 15 wounded.

Fortunately Teutonic efficiency, much though the Teuton admires it, is seldom of the all-round type. In this case the intruder, though he contrived to find the right places to bomb, bombed them at the wrong moment—at 12.12 p.m., when his prospective victims were almost all away at dinner. Otherwise he would have scored a genuine bull's-eye. Doubtless he reported to his superiors that he had done so.

In any case Pembrey was in full working order again within 48 hours.

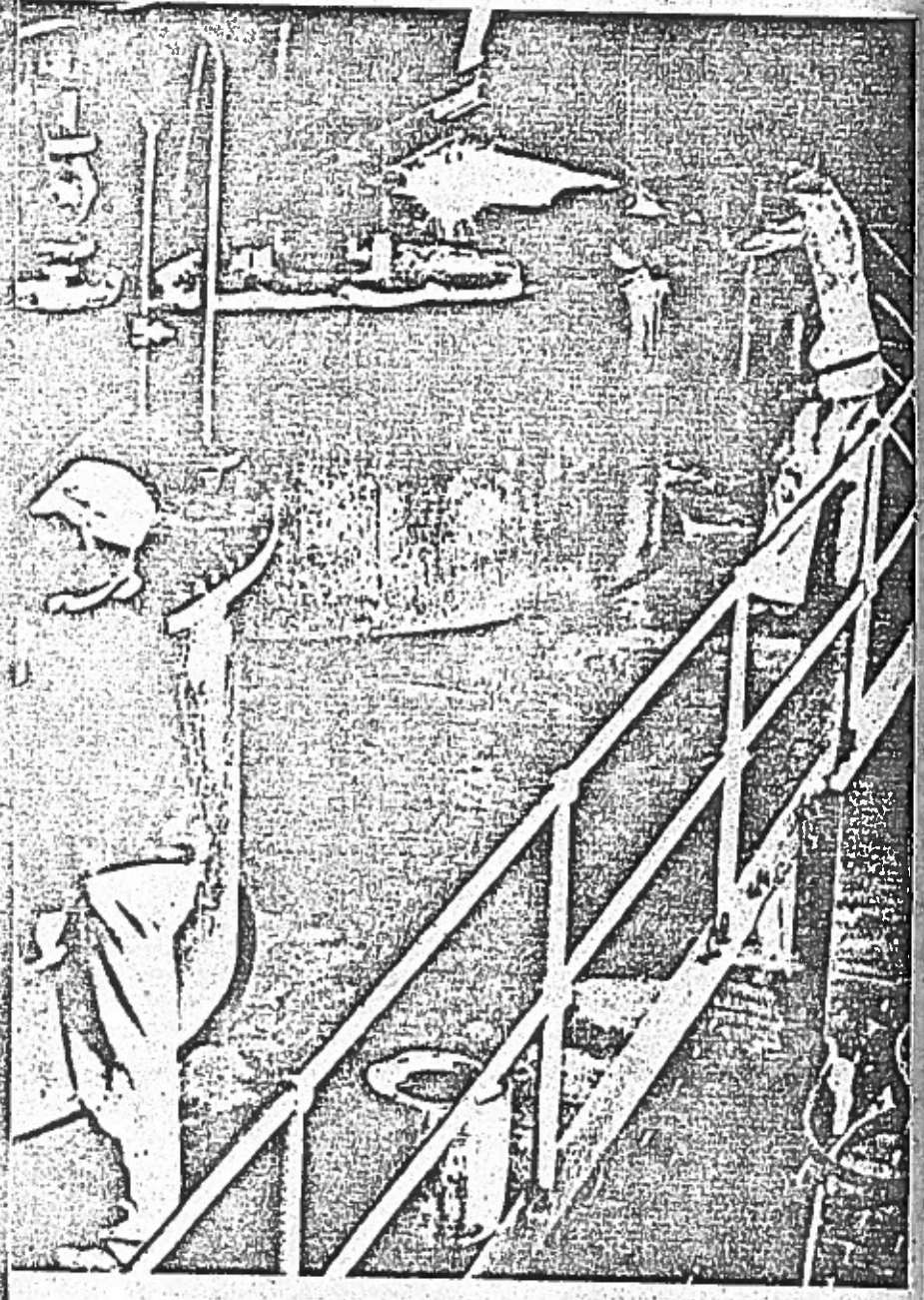
CHAPTER EIGHT

CHORLEY, AND ELSEWHERE

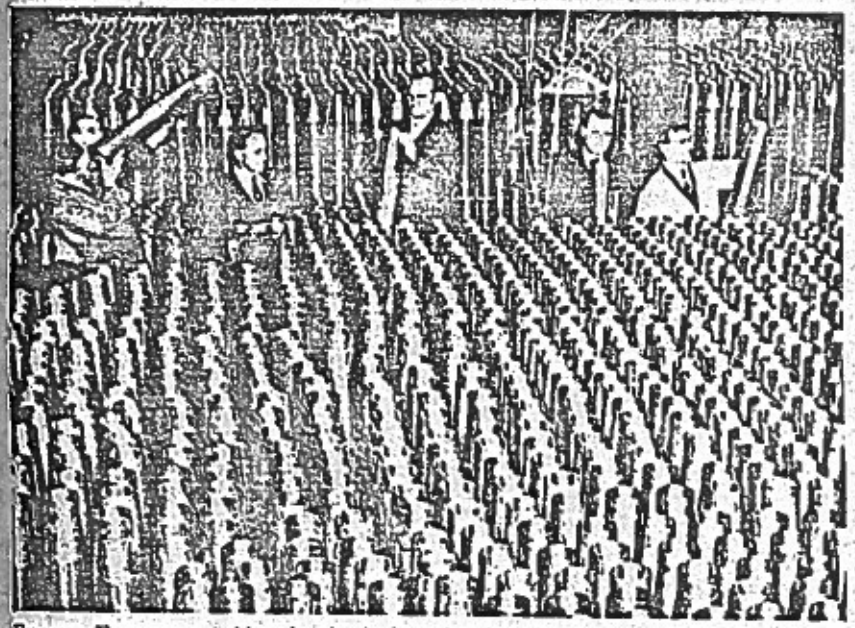
In our visits to the Engineering and Explosives Factories we have been enabled so far to study the design and manufacture of modern weapons of war, together with the production of the various types of explosives implicit in their operation.

We come now to the Filling Factory, whither all shells, bombs, cartridge-cases, fuses and the like are dispatched, on completion, to undergo the necessary charging process. Of the several factories at our disposal we will select the Royal Ordnance Factory, Chorley in East Lancashire, 21 miles north of Manchester. The town of Chorley lies some two miles away.

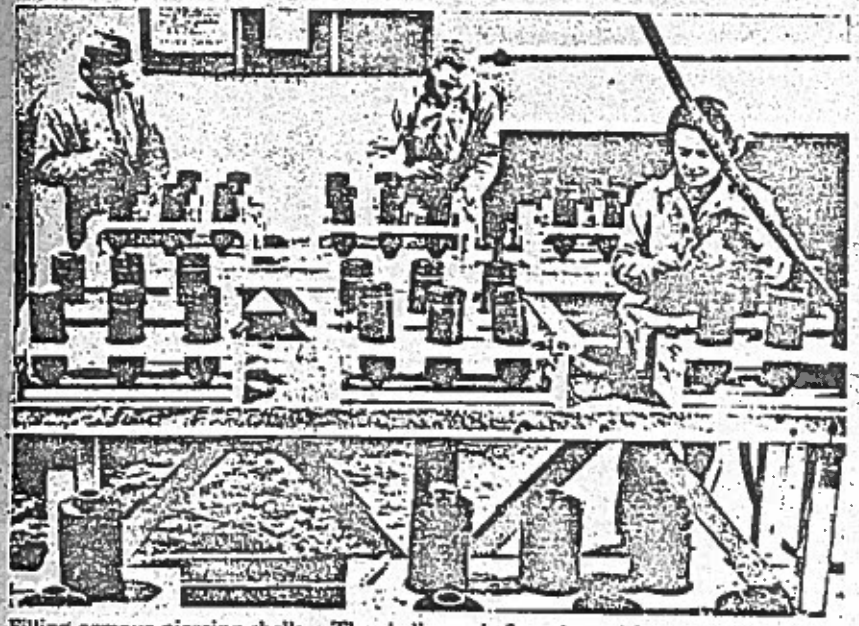
The Chorley Factory is an establishment of absorbing interest for more reasons than one. In the first place it is one of the 'permanent'



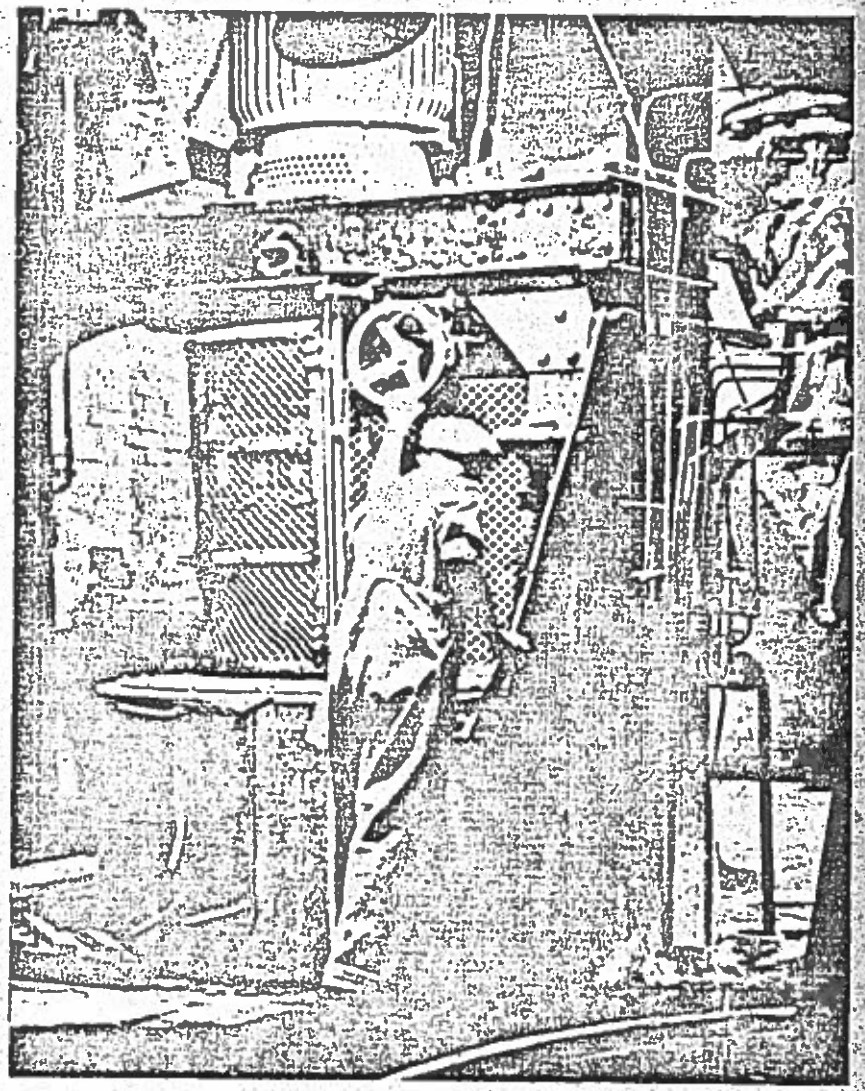
...nspectacular, highly skilled, and infinitely responsible. Ceaseless vigilance is the keynote.



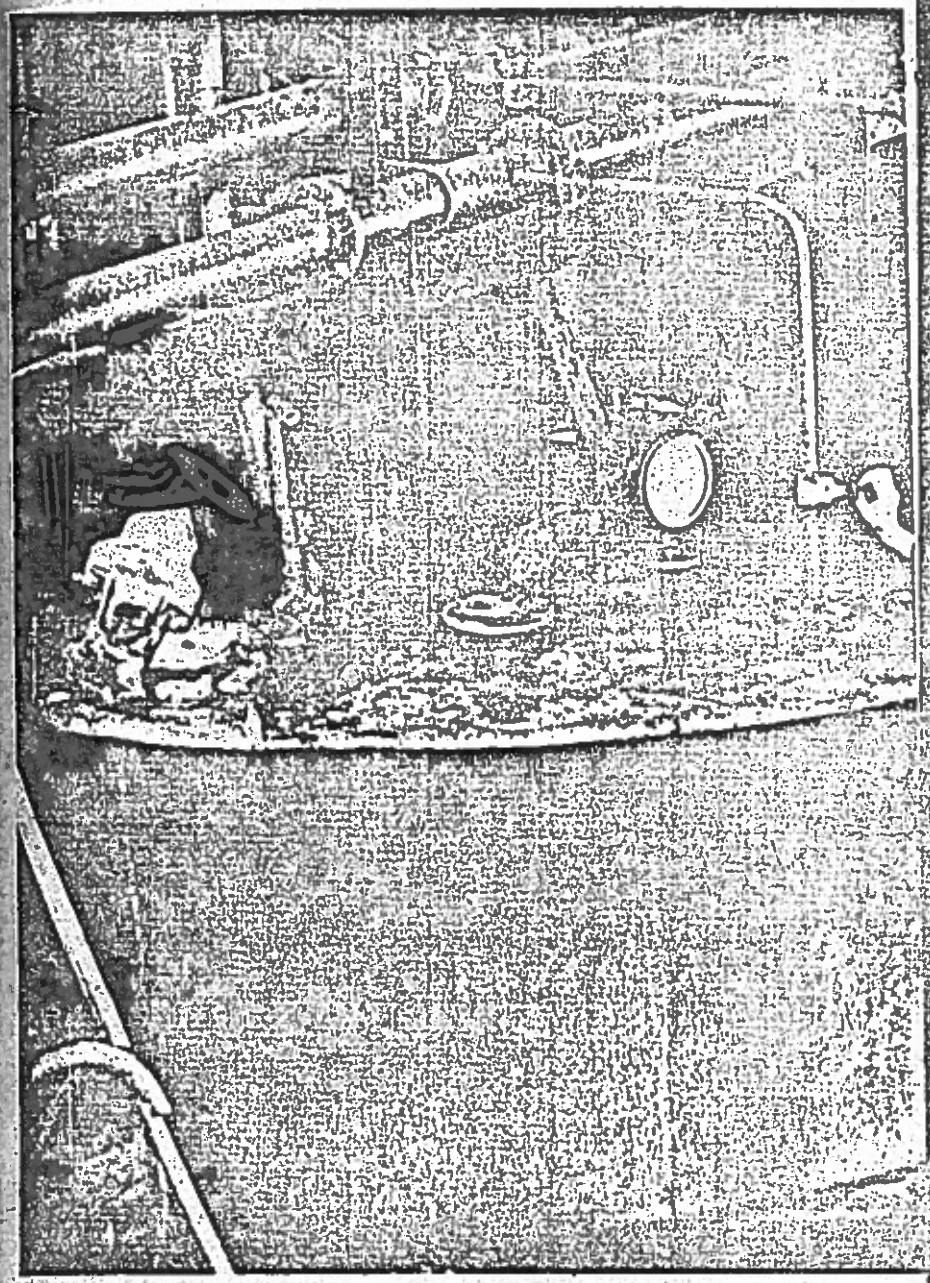
Filling Factories. Already checked on leaving the Engineering Factory, every component is re-examined before being used. These are 3·7 A.A. cartridge-cases.



Filling armour-piercing shells. The shell-case is first cleaned by suction (girl with flexible pipe), then filled by hand from a can containing liquid T.N.T. *Chorley*



EXPLOSIVES FACTORIES. Centrifugal drying machine for ammonium nitrate used in the composition of H.E. (high explosive) shell and bomb fillings. *Pembrey*



Sulphuric/nitric acid mixing-tanks at Pembrey. Work at the Explosives Factories is

Owing to the care with which the routine safety precautions were observed by all concerned, Pembrey throughout the war was kept singularly free from serious mishap ; but not entirely. Upon the night of November 1st, 1941, an explosion occurred in the mono-nitration plant, which resulted in considerable material damage and the death of two men.

The building concerned was known as P14, with brick walls and a light corrugated iron roof. It contained five nitrators, four of which were in operation on the night in question. The process of mono-nitration, the reader may remember, consists in the treatment of a charge of toluene by a mixture of nitric and sulphuric acid, fed into the nitrator by gravity, and kept in constant motion by a mechanical stirrer. Two essential factors in the process are, firstly, to maintain the acid supplies in certain fixed proportions, and secondly, to prevent the temperature of the mixture from rising above a certain level. Normally, the thermometer is examined every five minutes.

On the night of November 1st work was hampered, and ordinary risks intensified, by the fact that an air raid was in progress in the neighbourhood from about 9 p.m. to 11 p.m. In P14 the customary precautions were taken : that is to say, the acid-feeds were cut off and the men employed in the building were ordered to retire to the shelter, from which one or more of them emerged periodically to observe conditions in the nitration house. (It should be remembered that some of the nitrators contained charges of toluene.) Nothing untoward happened, however, and after the All Clear had been sounded the night shift, who had now come on duty, set four out of the five nitrators in P14 to work again.

What happened next is best visualised from the experiences of Assistant Foreman E. B. H. Williams. He had visited P14 shortly after 11 o'clock, and finding that work was now proceeding normally, departed for the canteen to warm up his evening meal. He had no sooner arrived than he heard the sound of an explosion, followed by another, from the direction of P14. He hurried back, to find that the roof above No. 1 nitrator had been blown off, and that that end of the building was on fire.

His first (and most proper) proceeding was to mount the platform outside the building, where the mixed acid storage tank and toluene storage tank were situated, and there close the valves through which the nitrators below were fed. Then he hurried down to ascertain the fate of the seven men whom he had left in the building a few minutes previously—five process-workers, a shift-fitter, and his mate. Four of these, he found, had already been accounted for : one had actually been blown from the building, and the others had come running out with their clothing on fire. All four were badly burned, and two of them, W. M. Evans and C. Bowen, died shortly after.

Much concerned for the safety of the other three men, and unaware that they had left P14 just before the explosion, Williams immediately entered the building, accompanied by Fireman H. J. Gurr, and, regardless of the flames and the heavy toluene vapour (which is highly explosive at certain temperatures), made a prolonged search, while Gurr kept the fire in check as far as possible with water. Finding no one, both men withdrew.

The explosion had taken place in No. 1 nitrator. Nos. 2, 4 and 5 were still a potential source of danger, and Dr. Marsh, the Night Supervisor, immediately emphasised the necessity of closing the foot-valves of the acid tanks which served them. These were situated inside the building. Williams immediately volunteered for the duty, and unhesitatingly re-entered P14, where he succeeded in closing the valves and so averting an explosion in any of the remaining nitrators. This done, he succumbed to the heat and fumes, and collapsed. He was removed on a stretcher to the surgery.

As soon as he recovered he insisted upon returning to P14, to stand by in case of further incident. In fact, he did not go off duty until his normal time of 6.30 next morning.

Mr. Williams and Mr. Gurr were both awarded the British Empire Medal.

CHAPTER ELEVEN

THE HUMAN FACTOR

A ROYAL ORDNANCE FACTORY, or for that matter a workshop of any kind, does not entirely depend for its smooth working upon the excellence of its technical equipment ; there is the human machine to consider as well. And during the Second World War there were 350,000 of these.

The chief difference between a man and a machine is that you can keep a machine running indefinitely—by night and day, if need be—and if any particular part wears out you can replace it by another. But no part of the human machine must ever be allowed to wear out ; and this means that constant and anxious attention must be paid to its maintenance and welfare. This proviso applies with especial force to the Royal Ordnance Factories, for the State must be a model employer.