THE INDIAN RAILWAY ENGINEER

...L. 5 NO. 1 JULY 1957 50 NAYE PAISE

Printed and Published by S. Sundaram at S. R. Press, Tanjore, for
"The Indian Railway Engineer", 79, Jayprakashnagar, Goregaon, BOMBAY.
Managing Editor: T. S. N. Rao

Y/14

THE INDIAN RAILWAY ENGINEER

(A Quarterly Journal devoted to Railway Matters of technical interest)

79, Jayprakashnagar, Goregaon,

BOMBAY

Grams: INDRAIL, Goregaon Phone: 84311

VOL. 5 NO. 1 ANNUAL NUMBER JULY 1957

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Railway Administration & Management Past & Present

ORIGINALLY all the Railways of India were Company-owned and Company managed. The Major Railways had their Board of Directors in England while the Minor Railways were owned and managed by the Princely States.

The Board of Directors in England appointed their Agent in India, and entrusted him with the task of managing the Railway concerned for them. Usually such an Agent being the man on the spot was given fairly wide powers, but matters of policy had to be referred by the Agent to what was then known as the Home Board.

As these Directors and Shareholders in the various Railways had invested a good bit of money in these various Railway ventures, it was the Agent's job if he was to hold his position to see that the Shareholders got a good return on their investment.

The Railways of India of the past while they assisted in the development of the country, did not have this as their primary aim. On the contrary the principal aim was to exploit the country and reap a financial harvest for the Shareholders in England.

In the course of the exploitation all materials from rails to the last split pin had to be purchased from England as a matter of established policy. This provided a good deal of profit to English firms for which India had to pay and at the same time provided employment for a large number of Englishmen at home.

Indigenous raw materials and manufacture were generally discouraged on the grounds of unsuitability or lack of know-how.

The Railways of India provided a vast field of employment to Englishmen right from the Administrative grade to the lowest supervisory grade. The covenanted staff received fabulous salaries, fat provident funds, sizeable overseas allowances, passages to and from for themselves and their families, privileges of first class free travel in the country for all of which India paid.

The Englishmen drawing these lucrative salaries were drawn from various strata of society. While the top Administrators in the Agent's Office were the public school tie type and had passed through the various Universities and were usually related to the Directors or Shareholders, this was not the case with all covenanted staff. The Civil Engineers were mostly Cooper's Hill men, that College specially catering for Civil Engineering in India, but most of the others were from the rank and file. This was specially so in the Mechanical and Transportation Power Departments where men who were fitters and Machinemen and practical engineers completely innocent in most cases of theoretical technical knowledge become Assistant Works Managers, Works Managers and even Chief Mechanical Engineers, Transportation Superintendents and Chiefs of other technical departments.

However ignorant they might have been in their theoretical knowledge, with long experience they had acquired the rule of thumb and were gifted generally with commonsense and an engineering sense which compensated for their other deficiency. Only a few of them could write their mother tongue without gramatical errors or express themselves lucidly in reports, but they could take there coat off and roll up their sleeves and get down to any job and get the better of it.

Practical men as they were, they dealt with problems as they arose in a practical way, efficiently, quickly and with very little writing about it, which they generally dreaded. They believed much more in discussion across the table and quick decisions whether of policy or finance or technology and the implementation of these without loss of time.

They had certain innate characteristics which stood them in good stead in their administration, management and supervision. They generally had a fund of common-sense a passion for punctuality (which has lost its meaning today), initiative, push and determination. With these qualities they ran the Railways successfully.

Further these Englishmen had time to think and plan, experiment and evaluate because they left routine matters to their subordinates in whom after trial and error they had the utmost confidence. The Administrators and Managers devoted their time and energy to the introduction of new ideas on the Railways they controlled.

It is because of this that a Railway Board was constituted on an all India basis, a Standards Office came into being, Indian Railway Conferences were started, with their Sub-Committees for Transportation, Traffic, Mechanical Engineering, Metallurgy, Medical Relief etc.

Exchange of ideas were encouraged. Besides this, while on "home leave" these high placed officials watched the progress made by Railways abroad and introduced such vital items as spring buffers and drawgear, electric train lighting, vacuum brakes, electric traction, colour light, automatic signalling, air-conditioning etc. on the Railways of India.

Experts were imported in the fields of technology who introduced Mass Production Systems, Scheduling of Locomotives and Carriage Repairs, modernisation of workshop machinery and tools.

This is a record of the past but what of the present?

Indianisation was started in the twenties of this century and has grown apace. While upto the thirties the Railways were managed predominantly by Englishmen, with a sprinkling of Indians in the lowest rungs of management, the pendulum has now swung in the other direction, the Railways are run for all practical purposes by Indians.

The Second World War gave a filip to Indianisation and with the advent of Independence in our country in 1947, the Englishmen in control of our Railways were given attractive terms for premature retirements and they all jumped at them. Some did this because the conditions offered were good, others because they did not wish to serve under Indian Superiors, and still others because they felt that if they left in a body, Indians would not be able to run the Railways.

Unfortunately for the Englishmen this wishful thinking has been belied. India and Indians have been able to manage the Railways of the country. Intelligent Indians with keen observation, a will to work and learn were found to step into the shoes of their English superiors and run the railways even at times of great stress like the partition of India, which had never been experienced by Englishmen. With massacre and bloodshed facing them they did not shirk their responsibilities but held on to their post tenaciously until relief and assistance could be supplied.

While this is a glorious record in the annals of Indian Railways, the aftermath is not so spectacular. There is no doubt that the "Railway Main Spring" wound tightly by Englishmen is gradually running down.

A tour of inspection of line or in Railway Workshops, will indicate that officers with accelerated promotion to their credit are looking for higher promotions without a desire to consolidate their knowledge and experience of their departments by hard work and intensive study. Haphazard method of working where any shabby thing is good enough is today an undesirable feature. Discipline has come to such a low state, that control over labour is nearly lost. With a lack of support from those above to those below, initiative, push and drive are being stifled. The inclination by all concerned is to take the line of least resistance and do only so much in work and achievement as will keep away the wrath of superior authority.

While it is admitted that records are being created by the Transportation Department in the handling of goods and passenger traffic, these are not entirely the fruits of sound planning and meticulous execution. They are more a contrast between previous slack working and an effort to liquidate inefficiencies where found.

(Continued on page 33)

The United Kingdom Coal Industry

THE mining industry occupies a key position in the UK national economy. It provides over nine-tenths of the power supplied to British industry, mploys over 700,000 workers and contributes directly bout £ 500 million to the net national income. Since 946 the industry has been under public ownership and ontrol under the National Coal Board, which has put ıto operation a long term plan for reorganization and evelopment. When this programme is completed four-fths of Britain's coal will be coming from virtually new ıines. The object of this paper is to outline the history f the industry, describe its current problems and show ow those problems are being tackled.

IISTORY

Coal extracted from surface seams was used in Britain s a domestic fuel as far back as the Bronze Age — some ,000 to 5,000 years ago. Later on, its value for this urpose was well known in Roman Britain. The first ritten mention of coal dates, however, from the Anglo-iaxon Chronicle of A. D. 852 which refers to the lespatch of '12 loads of coal' to Peterborough Abbey. The early thirteenth century saw the beginnings of an rganized coal industry when Henry III granted a cence to dig for coal at Newcastle-on-Tyne. In 1306 here are records of shipments of coal from Newcastle ɔ London for domestic purposes and for forges and, few years later, of exports to continental Europe. Ɔuring the next few hundred years the mining of coal by ery primitive methods extended to most of the present-ay coalmining areas, but by 1700 the annual output was :ss than three million tons.

'HE PERIOD OF EARLY EXPANSION

The great expansion of the industry after this time, nd particularly after 1800, can be attributed to three ıain causes – a vast increase in demand stemming from ıe Industrial Revolution and the increase in population hich accompanied it, radical changes in methods of ansport and progressive improvements in mining :chniques.

Perhaps the most important of the early events of the ndustrial Revolution was the discovery by Abraham Ɔarby, about the year 1709, of a method of smelting iron ith the use of coal (in the form of coke) instead of harcoal – which was rapidly becoming scarce. The triking development of Britain's iron and steel industry, on which the progress of so many other industries largely depended, owed much to this early discovery. Meanwhile coal was being used more and more extensively for boiling and evaporating purposes in the growing glass, chemical, soap and sugar industries. Moreover, the introduction of steam-driven machinery in a widening range of industries created an ever-growing demand for coal as a source of power. The domestic use of coal for heating purposes also had an important industrial aspect for it made habitable for large populations many areas which were previously habitable only in summer months. In the nineteenth century coal found important new uses – in the generation of gas, as a source of valuable chemical by-products and, later, in the generation of electricity.

As regards transport developments, the replacement of pack horses and sailing ships by railways and steam ships not only created new demands for coal as a means of propulsion but made it much easier to transport coal over long distances.

Within the coal mining industry itself the principal technical developments in the eighteenth century were the introduction of pumping engines and winding engines. Pumping engines became an urgent need because the mines were reaching ever deeper into the earth and were increasingly subject to subterranean flooding. This need prompted many new inventions. One of the first was Thomas Savery's steam pumping engine which appeared about 1698 and was capable of drawing water out of the pits at the rate of 60 gallons a minute. Savery followed this by a better machine termed the 'Miners Friend'. A few years later Thomas Newcomen devised a beam engine which employed steam at atmospheric pressure, and 60 of these engines were subsequently installed in the collieries around Newcastle. In 1769 James Watt patented a pumping engine with a separate condenser, which greatly improved its efficiency. The problem of hoisting coal to the pithead found a satisfactory solution in Watt's rotary engine, introduced about 1787.

Of the other early improvements in technique one of the most important was the introduction of the miner's safety lamp by Sir Humphrey Davy in 1813. This greatly reduced the danger of underground explosions from 'fire damp' (methane gas). A further development was the substitution of rope haulage in the pits for hand and pony haulage.

On the other hand, progress in one major direction, the substitution of machinery for manual labour at the coal face, made slow progress. The first coal cutting machines did not appear until the end of the nineteenth century By 1909 some 1700 coal cutting machines were in operation.

During the early period of coal mining employment conditions had been extremely bad and women and children were engaged on hard and dangerous tasks for lengthy periods. In 1842 Lord Shaftesbury initiated legislation which forbade the underground employment of women and girls and of boys aged less than 10 years. The Coal Mines Regulation Act of 1850 laid down rules for the safe running of mines and made provision for the appointment of inspectors to see that the law was carried out. Further legislation included an Act passed in 1908 restricting the working day to 8 hours.

Between 1750 and 1850 Britain's coal output expanded ten-fold, and by the end of the nineteenth century there were 3,000 mines in operation producing 170 to 180 million tons a year. In export trade Britain achieved a predominant position, due largely to the proximity of the coal fields to the shipping ports, unrivalled shipping facilities and the quality of coal supplies. Exports rose from an annual average of 7.5 million tons in 1855–64 to an average of 73.3 million tons in 1901–10.

In the peak year, 1913, the industry produced 287 million tons of which 94 million tons were exported. The industry then employed 1,107,000 men.

RECESSION AFTER 1913

After 1913 output tended to decline. The immediate cause was the outbreak of the first world war, which led to the shortages of manpower, plant and materials. The industry was confronted, however, with much more persistent problems. A major problem was the rapidly rising cost of production, due in part to the increasing difficulties of mining: the very fact that the British coal mining industry had developed so early meant that many of the best seams of coal were now exhausted and fresh coal had to be mined from deeper and thinner seams. The industry was also faced with increased competition from newly exploited continental mines. This occurred at a time when the general demand for coal was checked by a heavy depression in heavy industries using coal (e.g. iron and steel), by the introduction of more economical methods of combustion and by the exploitation of rival forms of energy—fuel oil and hydro-electric generation.

Owing to the difficulties in finding markets, the coal producers attempted to cut prices by reducing wages, which form by far the largest element in the cost of production. This was the main factor behind the numerous labour disputes which burdened the industry during the inter-war years. The aggregate duration in working days of such disputes rose from 46.4 million in 1907–13 to 105.1 million in 1919–25 and in 1926 there was a stoppage of unprecedented magnitude, accounting for the loss of 145.2 million working days.

The upshot of all these adverse circumstances was that coal production during the inter-war period was not only at a lower average level than between 1900 and 1913, but was subject to much greater fluctuations. In particular, shipments to other countries showed a marked downward trend. Before 1914, 33 per cent of production was normally exported. In the early 'twenties this figure was down to 30 per cent and in the early 'thirties to 20 per cent.

During the first world war the Government had assumed full control of the industry. In consequence of the unrest in the industry after the war a Commission was set up, under the chairmanship of Mr. Justice Sankey, to investigate the future of coal-mining. Members of the Commission reached divergent conclusions but the chairman and other independent members recommended state ownership of the mines on payment of compensation or unification by some other means.

Meanwhile, attempts to bring about economies by amalgamation of collieries, which had been considered by the Sankey Commission in 1919, were advanced by the Mining Industry Act 1926 which enabled colliery owners to prepare and submit to the Board of Trade schemes of amalgamation designed to secure greater economy and efficiency in working. To strengthen the move towards amalgamation a Coal Mines Act was passed in 1930, establishing a Reorganization Commission with the duty of bringing about the formation of larger and more efficient units. The Reorganization Commission was abolished by the Coal Act, 1938 which transferred ownership of mineral coal to the State and made it the statutory responsibility of a Coal Commission to accelerate the integration of the industry by still further reducing the number of separate undertakings. However, at the outbreak of the second world war in 1939 this process was not far advanced.

The second world war brought exports to a standstill and accelerated a downward trend in output, productivity and labour force. At the same time there was a

steady upward movement in demand. No longer were there problems of finding markets for the coal produced: the main task was to produce enough coal to meet urgent needs. The need for greater output per man employed and for more labour in the industry was stressed in a White Paper on Coal presented to Parliament in 1942. To achieve these aims the Government took over full control of the operation of all coal mines and of the allocation of coal raised. A Ministry of Fuel and Power was established with the general duty of ensuring the effective and co-ordinated development of fuel and power supplies, and of promoting economy and efficiency in their distribution and consumption. At its head was a Minister assisted by a Controller-General. To advise the Controller a national board and regional boards were set up.

THE REID REPORT

In 1944 the Government appointed a committee of seven mining engineers under the chairmanship of Sir Charles Reid to investigate the current technique of coal production and advise what technical changes were necessary in order to bring the industry to a full state of technical efficiency. In its report, published in 1945, the Committee stressed the urgent need for reconstruction in the industry to eliminate uneconomic units and make possible a wide range of technical reforms, which were outlined in the report. It emphasized the inability of the then existing system of ownership to carry out this reconstruction and recommended the setting up of an authority to carry out the changes on a national scale.

THE NATIONAL COAL BOARD

In 1946 the Coal Industry Nationalization Act was passed. This brought the coal-mining industry into public ownership and control under a public corporation —the National Coal Board. It transferred to the Board all coal-mines, all mineral rights in coal and any other mineral rights which were held by the Coal Commission or by colliery concerns and could not be developed except as a by-product of coal-mining; and most of the ancillary undertakings run by colliery concerns. On 1st January 1947, therefore, the Board took over 1,500 collieries and many ancillary undertakings such as brickworks, coke-ovens and by-product plants. The Board now operates about 900 collieries which produce nearly all the mineral coal, while the remainder are 'small mines' (of 30 or less men underground) run by private operators under licence from the Board. Opencast mining, for which the Ministry of Fuel was previously responsible, was transferred to the Board on 1st April 1952. The Board operates nearly half Britain's coke and by-products plants and is Britain's second largest producer of bricks.

DUTIES AND POWERS

The 1946 Act charged the Board with responsibility for securing the efficient development of the country's coal production and with making coal available in such quantities and at such prices as may seem to them best calculated to further the public interest, without giving undue preference or advantage to any consumer. The Board was empowered to mine, treat and sell coal and to prepare and sell coal by-products. It was given a monopoly of coal-mining, but not of distribution of coal or of the preparation and sale of coal by-products. In addition, the Board was especially enjoined to secure the safety, health and welfare of persons in its employment and the benefit of their techincal knowledge and experience.

PUBLIC CONTROL

The Board is responsible for the general fulfilment of its task to the Minister of Fuel and Power and through him to Parliament and the public. It is required to conform to any special policy directives which the Minister may give it on matters affecting the national interest, and to publish and submit to him an annual report and accounts, which he lays before Parliament. The accounts must be in the form which the Minister directs and must be audited by an auditor, whom he appoints. The Minister has other powers of control—over the use of capital funds, for the appointment and dismissal of members of the Board and certain other persons, and powers of enquiry. He is, in fact, in frequent consultation with the Board on a wide range of matters, though he does not in any way intervene in day-to-day administration.

Parliament exercises a general surveillance over the conduct of the coal industry as over other nationalized industries. Its principal instruments of control have, till now, been debates—including a debate on the annual report and accounts—and Parliamentary questions. A select committee of the House of Commons on the nationalized industries was appointed in 1955 to obtain and clarify for the benefit of Parliament, information about nationalized industries, but its terms of reference proved too narrow. The Prime Minister has announced that a new select committee is to be appointed 'to examine the reports and accounts of the nationalized industries.'

The Coal Industry Nationalization Act provided for the setting up of consultative bodies to represent the interests of coal consumers. Two coal consumers' councils at the national level have since been set up.

1. *The Industrial Coal Consumers' Council* whose members represent consumers, merchants and suppliers of coal, coke and manufactured fuel for industrial and other purposes involving supply in bulk.

2. *The Domestic Coal Consumers' Council* whose members represent similar groups concerned with coal for domestic use.

These councils are responsible to the Minister of Fuel and Power, not to the National Coal Board. The composition of the Councils is left to the discretion of the Minister, who includes representatives of the National Coal Board. At present, the industrial council has a chairman and nineteen members and the domestic council a chairman and twenty-five members. The councils are required to make annual reports to the Minister, who lays them before Parliament. Both the councils prefer to meet in private in order to encourage freedom of discussion.

The most important function of the councils is the general consideration of the commercial arrangements and activities of the National Coal Board, and to ensure that the monopoly in the industry set up by the 1946 Act shall have the maximum practical regard for consumers' interest. Quality and adequacy of supplies have been prominent among the subjects discussed.

The councils only consider complaints after they have been first put to the Board or the appropriate authority and a satisfactory answer has not been provided. The councils are therefore more free to discuss questions of a wider importance.

CONSTITUTION OF THE BOARD

The members of the Board are appointed by the Ministry of Fuel and Power and must appear to him to have had experience or shown capacity in industrial, commercial or financial matters, applied science, administration or the organization of workers. The 1946 Act laid down that the Board should consist of a chairman and eight full-time members, each responsible for a special Department. In 1949 the statutory limits of the Board's membership were changed to eight to eleven persons of whom not more than eight could be full-time and in 1951 the Board was reconstituted to include some part-time members free from departmental responsibilities.

The Board was again reorganized in February 1955, in accordance with the recommendations of a Committee on organization (under the chairmanship of Mr. Alexander Fleck) which it had set up in December 1953. The existing Board's members resigned voluntarily and the Minister of Fuel and Power appointed a chairman, deputy-chairman, six full-time and four part-time members, several members including the chairman being new appointments. The full-time members all share fully in responsibility for the Board's general policy but each of them is also concerned with a special aspect of the Board's activities.

DEPARTMENTAL ORGANIZATION

The Board set up a strong headquarters organization with a number of specialized departments. The Fleck Committee criticised the existing departmental organization. It recommended that 'Personnel' functions should be divided between two Departments, Industrial Relations and Staff, and not as formerly between three, Labour Relations, Manpower and Welfare, and Establishments. It further recommended that a new Purchasing and Stores Department should be set up. Production and Carbonisation Departments at Headquarters strengthened, the Medical Service given independent status, and a new Bricks Department set up. The recommendations were accepted save that for a Bricks Department; instead a Chief Brickworks Engineer was added to the Production Department. The Departments at present are therefore: Staff, Industrial Relations, Marketing, Purchasing and Stores Finance, Production, Scientific, Carbonisation, Legal and Medical Departments.

DIVISIONS, AREAS, COLLIERIES, GROUPS

For administrative purposes the Board from the first divided the coalfields of Great Britain into Divisions (see Table 1) most of which were sub-divided into areas, 48 in all, which formed the main units of management. To run Divisions the Board appointed subordinate non-statutory bodies called Divisional Boards, consisting mainly of the heads of certain functional Departments in each Division and delegated to them considerable authority.

The day to day running of collieries was in the hands of colliery managers who reported to the Area Manager and got help and advice from Area specialists. On the by-products side, there were Carbonization Departments at certain Divisional Headquarters, to whom coke-oven managers were responsible.

TABLE 1

THE BOARD'S DIVISIONS

Division	Coalfield	No. of Areas	No. of Pits	Approximate Annual Output in 1955 (million tons)
Scottish	Scotland	8	174	21.7
Northern (a) (N. & C.)	Northumberland Cumberland	4	68	13.4
Durham (b)	Durham	6	132	25.4
North Eastern	Yorkshire	8	112	43.5
North Western	Lancashire, Cheshire and N. Wales	5	72	15.4
East Midlands	Nottinghamshire Derbyshire Leicestershire	6	89	45.8
West Midlands	N. & S. Staffs Cannock Chase Salop Warwickshire	4	53	17.4
South Western	S. Wales Monmouthshire Dean Forest Somerest	7	163	23.8
(South Eastern)	Kent	1	4	1.5
	Total	49	867	207.9

(a) Northern (N. & C.) and Durham were originally organized as one division.

(b) Kent, originally organized as a Division, now operates as an Area.

The Fleck Committee suggested no alterations in the number of Divisions or Areas, but they found that too many persons were reporting direct to the Area Managers and they recommended that an intermediate link in the chain of command be inserted between Area and colliery. They also recommended some standardization of departmental organization at Divisional Headquarters and an end of the practice of appointing part-time members to Divisional Boards. These recommendations have been accepted in principle but existing part-time members were invited to continue in office.

The Board decided that the intermediate level of management between Area and colliery should be called Group, and the men in charge Group Managers. In all there will be about 200 Groups, each comprising not less than two collieries and most groups have now been established. The Group Manager will have only a small supporting staff.

The Committee recommended giving colliery managers assistants to help with administration and staff.

GENERAL POLICY

The main primary sources of energy used in Britain are coal, petroleum and water power, while the main secondary sources are electricity and coal gas.

Output of coal had, when the Board took over, been declining since 1913 and saleable output of deep-mined coal in 1946 was 181 million tons compared with 227 million tons in 1938. The fall in production was partly due to temporary factors arising out of the war and its aftermath and the uncertainty attending the prospective transfer of ownership. Longer term factors were, however, also important. The preceding thirty five years had contained two world wars when development was sacrificed to immediate production and a long period of depression and unemployment between the wars when coal output was restricted, financial returns low and the prospects of capital expenditure in coal far from alluring. After the second world war, only one-tenth of output was coming from mines opened since 1921 and two-thirds was coming from mines opened before 1900. The effect of high extractions without new development had been a progressive and accelerating decline in the capacity of the industry.

The main coal-bearing areas in Britain are (1) the Yorkshire, Derbyshire and Nottinghamshire field (2) the Durham and Northumberland field (3) the South Wales field and (4) the Scottish field and (5) Lancashire and North Wales. The relative importance of these different areas has changed greatly over the past 75 years. In the Durham and Northumberland, South Wales and Scottish fields many of the best seams have been exhausted, relative costs have been rising and output falling. In the Yorkshire and East Midlands fields, many pits are less than fifty years old, development is continuing and production expanding.

In spite of the decline in total output, coal supplies 85 per cent of Britain's energy needs. Workable reserves of coal are still large and have been estimated at 43,000 million tons, sufficient to last 200 years at present consumption rate, though certain high quality coking coals would be exhausted much sooner. On the other hand, nearly all petroleum is imported; and water power resources are limited. The immediate contribution of nuclear power is negligible and its development inevitably slow: it was expected according to the last published information to supply the equivalent of 5-6 million tons of coal in 1965 and 40 million in 1975, though technical developments recently mentioned by UK representatives at the World Power Conference suggest that these are under-estimates.

Energy demands have been rising steeply and are certain to go on rising. Sources of power alternatives to coal can with difficulty be developed sufficiently fast to meet even the rise in demand. Moreover, coal is still the most economical fuel for many purposes and can still be produced more cheaply in Britain than in most other countries. Investment in development of the coal industry shows a higher return in terms of addition to fuel capacity than any other form of investment in fuel and power.

The first and most important objects of Britain's fuel and power policy remain, therefore, the expansion of coal supplies and the development of the coal industry.

The National Coal Board is thus faced with two major tasks; securing an immediate rise in production to meet current demand and planning and executing a major scheme of reconstruction and new development to meet the increased demands of the future. To some extent, the two aims are conflicting, as development and long-term exploration and research absorb manpower and the output of certain pits is reduced during reconstruction.

PRODUCTION

The Board was successful in rising saleable output of deep-mines coal from 181 million tons in 1946 to 212 million tons in 1951 (see Table 7) through increasing productivity by mechanization, simple reorganizations and other short-term measures (see below).

In 1952 the Board was able temporarily to increase its labour force and therefore its production because a trade depression led to redundancy in textile and other consumer industries and thus made it easier to recruit labour to the mines.

The average labour force, however, declined from 716,000 in 1952 to 704,000 in 1955 and deep mined production fell from 214.3 million tons to 210.2 million tons. The published figures are for output of saleable coal and somewhat under-estimate the amount of current production compared with that of earlier years owing to improvements in standards of cleaning coal. For example, about 12½ million tons more dirt and waste was extracted from deep-mined output in 1955 than in 1947.

Throughout this period open-cast coal-getting was carried out by contractors first on behalf of the Ministry of Fuel and Power and from 1952 for the National Coal Board. It produced between 10.2 and 12.4 million tons of coal per year at a low cost in money and men.

PRODUCTIVITY

Between 1946 and 1951 productivity rose rapidly (see Table 7). Mechanization of cutting and conveying, which was already widespread, was extended and became the general practice, while improved machines and methods were introduced. Transport development was particularly important. In the six years up to and including 1952, the number of locomotives in Britain's mines increased from 80 to 510 (450 diesel, 60 electric) while many rope haulage systems were replaced by conveyor belts. At the same time some unproductive pits were closed and some of the more productive pits developed, with additional labour and machinery. Some labour savings were made possible both below and above ground by the unification of ownership, while others resulted from improving organization and methods at particular collieries.

By 1951 the process of increasing productivity by these relatively simple and inexpensive methods had been carried almost to its limits. Further progress depended on the development of machines for power-loading the coal cut from the face straight on to conveyor belts so that the processes of cutting, loading

and conveying can proceed simultaneously and continuously; on thorough reorganizations of underground transport, e. g. the introduction of the horizon system of mining, when the main roadways are straight and level instead of following the seams; and on major schemes of reconstruction and new development which were bound to take time to complete.

In 1952 productivity fell somewhat, mainly because of the larger intake of new labour requiring training and not contributing directly to production. Between 1952 and 1954 there was a gradual increase in productivity, and in 1955 productivity was at about the same level as in 1954 and higher than in any previous year. The main reason for the increase in productivity since 1951 is probably the spread of power-loading as the development of new machines made possible its wider application to varied coal-mining conditions.

The main methods of working coal used in Britain are the 'longwall' and 'bord and pillar' methods. In the first method, which accounts for about 85 per cent of output the coal is won along the whole of a long face in the seam and extraction is fairly complete. In the 'bord and pillar' method, however, extraction is only partial and large pillars of coal are left behind to support the roof. This a rapid method, suitable where seams are thick and only light support is needed.

The orthodox British method of longwall working is cyclical, by which three shifts are worked every 24 hours—loading the coal onto the conveyor takes place during only one shift, while the other two shifts are for cutting and bringing down the coal from the face, and for packing and ripping (i. e. packing the space from which coal was removed with waste to support the roof, and ripping down portions of the roof above roadways).

Of recent years attempts have been made to replace the cyclical method by continuous mining. The latter method avoids the necessity of completing the work of one shift before the next can start and also the inevitable dislocation to production in the event of a breakdown or hold-up in one phase of the cycle. Trials of new machines and equipment, including a large number of armoured conveyors, are being made in the process of developing fully mechanized continuous longwall mining. These armoured conveyors play an important part as they can be placed directly against the coal and be moved over section by section as the coalface advances (whereas in normal working the face conveyors have to be reassembled on each cycle of operation). They can also partially load the coal blown down on to them in conventional working where no power loading machines are used.

The percentage of mined coal, which is power loaded rose from 7½ in 1951 to 11.1 (or 27 million tons) in 1955. This coal was loaded by 544 power loading machines, most of which have been developed since the end of the second world war. The most widely used were the 142 Meco-Moore cutter loaders which loaded 9 million tons. Of the new machines, the most important is the Anderson Shearer loader, which has proved applicable (in conjunction with armoured conveyors) to many different conditions, where power loading was not previously applicable. 83 of these machines were in use in 1955 compared with one in 1952. Other machines include the Trepanner and the Joy Continuous Miner for continuous mining by the room and pillar system.

LABOUR

After the war the coal-mining industry had a severely depleted labour force. Many young potential miners had been absorbed into the Armed Forces while many of the youths conscripted to the mines as an alternative to serving in the Armed Forces, and of the older miners who had been asked to remain at work after normal retiring age, began to leave the industry. There was, moreover, strong competition for manpower for other industries and this competition has persisted. In addition to the general shortage there were acute shortages of skilled craftsmen, of mining engineers and of many types of specialists.

To remedy this situation the Board has made vigorous efforts to recruit more men and to reduce wastage. It has improved wages, and conditions, greatly increased facilities for education and training leading to promotion and has paid special attention to housing. The Board has built some 20,000 houses in selected areas, in addition to current housing programmes for miners. It has conducted recruitment campaigns, in which it has publicised these new attractions of a career in the industry.

These measures have had some success in maintaining a high rate of overall recruitment and in stimulating recruitment of boys under 18, but wastage has continued high and has exceeded recruitment in all but three of the years since nationalisation. Recruitment and wastage since 1953 is shown in Table 2.

WAGES AND CONDITIONS OF WORK

Pay increases introduced by the Board have raised average earnings (including the value of allowances in kind) per man-shift ($7\frac{1}{2}$ hours) from 36s 10d. in 1947 to 63s. 7d. in 1955 for face workers and from 28s. 10d. to 50s. 11d. for all workers.

The Board has not only had to raise wages to meet changes in the cost of living and to attract and hold labour in a competitive labour market, but has had to set about rationalizing the anomalous wage structure bequeathed to it by the many enterprises from which it took over. The first stage of this task was completed in 1955 when a new wage structure was agreed with the National Union of Mineworkers and introduced for 400,000 day-wage men in the industry. The new structure was based on a careful survey which identified 400 different jobs in the industry and grouped them into 13 grades for wage purposes. The new rates were only applied when the men did not lose by them and 30 per cent of day-wage men accordingly stayed on their old rates. Wages of day-wage men were again raised in February 1956. Current shift-rates for adult workers underground now vary from 30s. 1d. to 38s. 1d. according to grade, and weekly minima for the lowest grade of adult male workers are £9. 0s. 6d. for underground workers and £8. 0s. 6d. for surface workers. Investigations preparatory to the negotiations of new rate structure for piece workers and task workers are proceeding but will not be quickly and easily completed.

In May 1947 the Board reached an agreement with the National Union of Mineworkers for the introduction of the five-day week. The normal working week for underground workers is five shifts of $7\frac{1}{2}$ hours each, plus the time it takes to raise the workers to the pithead after each shift. Since November 1947, however, most underground workers have voluntarily worked an additional Saturday morning shift in accordance with an understanding to that effect between the Board and the NUM.

Employees in the industry receive two weeks annual holidays with pay in addition to six statutory public holidays. Under a contributory pension scheme they are entitled on retirement from the industry to a pension additional to any to which they may be entitled under the National Insurance Act.

EDUCATION, TRAINING AND PROMOTION

The Board's policy is to recruit boys under 18 and train them. Preliminary training takes place partly at Group training centres and partly at technical colleges and lasts for 16 weeks during which normal wages are paid. After preliminary training, boys are allocated to a colliery where the colliery training officer is responsible for the continuance of training and for supervising the personal welfare of the new entrants. It is customary to give boys an all-round training in underground work so that even those who intend to be face-workers spend time on haulage. Boys who want to become crafts-men serve a five years apprenticeship in their chosen trade and may be sent to part-time day courses at technical colleges to obtain recognised qualifications.

Boys selected for ability are released from work to attend technical colleges for part time day courses of study leading to National Certificates in mining and mining survey and have in this way an opportunity of promotion to colliery manager or under-manager. The National Coal Board also awards 100 scholarships a year tenable at any University for boys inside and outside the industry to enable them to become mechanical or electrical engineers.

SAFETY, HEALTH AND WELFARE

The safety, health and welfare of workers in mines and quarries are the subject of comprehensive legislation. Protective legislation in mines began with an Act of 1842, which forebade the employment of women underground, and successive measures since then laid down detailed requirements for the safe conduct of operations and dealt with such matters as ventilation, dust suppression, rescue work, first aid and the initial medical examination of certain new entrants by official doctors. The latest stage was reached when the Mines and Quarries Act was passed in 1954. This Act establishes the basic modern principles of safety, health and welfare, leaving the details to be dealt with in statutory regulations; it both consolidates the previous law and brings it up to date. Apart from technical matters, it also covers such subjects as the general responsibilities of owners and managements, the appointments and duties of officials, training, welfare, the powers of official inspectors, statutory qualifications of managers and under-managers, employment of women and young persons, and inspection on behalf of workmen.

The Ministry of Fuel and Power is generally responsible for the administration of these enactments while the Mines and Quarries Inspectorate, which is part of that Ministry, is directly responsible for their enforcement.

The National Coal Board is expressly charged with securing the safety, health and welfare of its employees and has set itself to accomplish this in all practicable ways.

Safety. The Board has its own safety organization—a Standing Committee on Safety, a Chief Safety Engineer, and Safety Engineers at Divisions, Areas and the largest collieries. It conducts courses of safety training for workmen and officials and is constantly on the alert for new methods of reducing risks. Its research programme includes a number of projects with a direct bearing on safety. Examples of recent voluntary action by the Board to reduce risks include the use of fire-resistant conveyor belting, the stone dusting of roadways and other dust control measures, and the withdrawal of light alloy equipment from the coal face pending the development of an alloy unlikely to cause dengerous sparks.

The Ministry of Fuel and Power runs extensive Safety in Mines Establishments at Buxton and Sheffield.

Health. The health services provided by some of the larger collieries before 1947 have been extended by the Board to provide for the coal industry a comprehensive industrial medical service. The Board's employees, like all UK residents, already have available to them the personal medical service (National Health Service).

The aims of the Board's Medical Service are, briefly, to ensure that new entrants are fit for work in the mines, to help the men in the industry to keep healthy, and to assist in placing disabled workers in suitable jobs. By the end of 1955 there were 66 doctors employed full-time by the Board and 302 medical centres at collieries. Each centre is staffed by a State Registered Nurse usually assisted by a specially trained staff. The centres give first treatment for injuries and illness at work and are visited regularly by the Board's doctors who also see workers by appointment and discuss their health problems with them. There are also first aid posts manned by men trained in first aid throughout the collieries including the smaller pits, and all Divisions have schemes for further first aid training.

During the year 1955, nearly all new entrants to the industry were examined clinically. All new entrants in South Wales had an 'X-ray' of the chest and similar arrangements were also introduced in the Scottish, Durham and Northern (N. & C.) Divisions. An increasing number of periodic examinations were made of men employed at the Board's ancillary plants who, like other workers involved in producing materials such as tar and pitch, are exposed to the risk of skin cancer.

A major preoccupation of the medical service is to reduce the toll from the occupational diseases of coal-mining. One of the most formidable of these is pneumoconiosis which has been common in the coal-mines of South Wales and became more so as mechanization increased coal dust concentrations. The Board has reduced dust consentration by damping and stone dusting and the use of specially designed drills. These measures have greatly lessened the reported incidence of pneumoconiosis in South Wales, but the figures of its incidence have been rising elsewhere probably because more mine-workers know about the dangers of the disease and the advantages of treatment and so report on this ailment. It is almost certain that the disease is in fact becoming less prelavent as more progress is made with dust suppression measures. No cure of dust diseases is known but it is possible to give considerable relief of symptoms. In some cases, to halt the further progress of the disease, it is thought best to remove the man from further exposure; in others it is thought that the man can safely continue in his old work provided he works only in approved dust conditions and is subject to medical re-examination from time to time.

Measures taken since 1947 have helped to reduce unemployment among sufferers from pneumoconiosis by more than four-fifths. The most important factor in achieving this has been that, under the National Insurance (Industrial Injuries) Act, men may be paid benefits for pneumoconiosis even though they continue work in the process which caused it; there is no automatic suspension from the scheduled occupation as there was under the Workmen's Compensation Acts.

Another factor is that in 1951 the Ministry of National Insurance introduced a scheme whereby persons who had been certified as suffering from pneumoconiosis and suspended under the Workmen's Compensation Schemes could apply to the Silicosis Medical Board for permission to return to work in the coal-mining industry under approved dust conditions.

Colliery managers and personnel experts on the Board's staff co-operate closely with medical and social workers of the Miners' Rehabilitation Service. This service comprises seven residential centres in England and Wales. The first of these centres was set up in 1939 by a group of colliery owners with the co-operation of the National Union of Mine-workers. As an outcome of this experiment, the Ministry of Fuel and Power three years later requested the Miners' Welfare Commission to develop a nation-wide service. In 1951 the centres were transferred to the National Health Service. Miners have priority for admission, but a small percentage of other orthopædic patients are taken. There is also one miners' rehabilitation out-patient centre in Scotland under the Coal Industry Social Welfare Organization. All patients admitted to the centres have sustained serious injuries. For the centres in England and Wales, the average period between injury and admission is four months and the average period of total disability is six months.

Welfare. Organized welfare in the industry began with the Miners' Welfare Committee set up in 1920 following the recommendations of the Sankey Commission. In 1939 the Welfare Committee became a Welfare Commission. In 1947 the N. C. B. was also made responsible for providing for the welfare and education of its employees, and, to avoid overlapping, a National Miners' Welfare Joint Council was created to direct and plan all welfare arrangements. Welfare expenditure was by this time covered by a 1d. a ton statutory levy on output (providing about £800,000 a year), a 5 per cent levy on mining royalties (about £110,000 a year), and a further 2d. a ton which the N. C. B. volunteered to provide. In addition, the Board took over the responsibility for upkeep of baths and improvements to canteen at an annual cost of £1,500,000 (or nearly 2d. a ton of output). Out of this income, miners have been provided with pithead baths, institutes, canteens, convalescent homes, scholarship funds and a variety of recreational facilities.

In 1952 the statutory levy came to an end and the Board took over responsibility for all colliery welfare (baths, canteens, and so on) while the social welfare side became the responsibility of a new organization known as the Coal Industry Social Welfare Organization, which was controlled jointly by the Board and the miners' trade unions. To finance social welfare the Board make available a first payment of about £1 million held by the Miners' Welfare Commission for social welfare purposes.

An outstanding welfare achievement has been the provision of pithead baths. By the end of 1955 there were baths at 622 pits with accommodation for nearly 677,000 men. It is estimated that the pithead bath programme will be virtually complete by the end of 1956. The Board in 1955 also operated 728 canteens with annual sales of £7½ million.

The Coal Industry Social Welfare Organization is concerned with providing and maintaining buildings and grounds for recreation and sport, with organizing and encouraging sport, indoor recreation, cultural and social activities, with youth work, with the social needs of the sick and disabled and with administering a fund for giving scholarships and exhibitions at universities to promising children of mineworkers. Its activities on behalf of the sick and disabled extend almost into the medical field as it operates a number of convalescent homes as well as the out-patients rehabilitation centre at Uddingston in Scotland. In 1954, it spent nearly £700,000 on social welfare of mineworkers and their families of which nearly £ 500,000 was for buildings for recreation and sport.

NEGOTIATION OF WAGES AND CONDITIONS

Up to 1943, miners' wages were negotiated on a district basis. Each mining district had its own trade union, and negotiations were conducted in England and Wales through boards based on the various coalfields and in Scotland through a conciliation board. The mine-owners, on the other hand, were united in the Mining Association of Great Britain.

The miners' unions were loosely linked in the Miners' Federation of Great Britain, but the Federation had little power and there were substantial differences of practice and output in the different districts.

From 1921 to the general strike in 1926, a national board acted as a court of appeal from district decisions. In 1930 the Government passed an Act providing for national conciliation machinery, but owing to the mine-owners' opposition the machinery was never worked.

In 1942 a Board was set up to investigate wage claims and arrangements for negotiation and conciliation in the coal-mining industry. On its recommendation a national minimum wage was introduced and a national conciliation scheme was agreed. The scheme provided for a national joint negotiating committee of 22 members, to which reference might be made by district joint negotiating committees. If this national committee could not decide a dispute it could be referred to a National Reference Tribunal, consisting of three permanent, independent members and four assessors without voting rights, two representing labour and two from managements.

In January, 1945, the National Union of Mineworkers was formed and took over the industrial activities of the District Unions which were, however, left in being

as District Associations with a limited independence in certain matters. They might, for example, if they desired, raise and administer themselves separate funds for various non-industrial benefits.

In the autumn of 1946, negotiations on machinery for conciliation and wagefixing and for joint consultation were begun between the NUM and the National Coal Board in anticipation of the transfer of the mines to public ownership in January, 1947. Agreements signed in December 1946 and January 1947, continued with certain modifications the 1943 conciliation scheme.

Under the new agreement, which is still in force, the Joint National Negotiating Committee consists of 10 members appointed by the National Coal Board and not more than 14 representatives of the NUM. The constitution of the National Reference Tribunal remains unchanged. District conciliation boards have been set up consisting of six members of the Divisional Coal Board and of NUM representatives whose number is determined at district level. District referees are appointed to adjudicate unresolved differences.

Entirely comprehensive pit conciliation machinery has been established. Disputes that cannot be settled between the workmen concerned and the immediate officials must be discussed within three days with the manager or his representative; after three days, unless a settlement is reached or is in view in the opinion of a trade union official, the dispute must be referred to a pit meeting between representatives of the Union and management. If the pit meeting decides that it cannot resolve the dispute or has failed to do so within 14 days, the matter is referred to the District Conciliation Boards, who refer it to a Disputes Committee appointed for purpose. If once again unresolved within 14 days, the dispute is referred to an umpire appointed by the District Conciliation Board. If he is satisfied that the question is merely a pit question he will examine it with the help of assessors representing management and workers and give his decision, but if he is not satisfied that it is a pit question he must notify the District Conciliation Board, which will deal with it under the District Conciliation Scheme.

Separate arrangements exist for the coke-oven and by-products branches of the industry.

Incidence of Disputes. The industry has, since the war, been disturbed by a large number of disputes leading to stoppages of work. All these stoppages, however, have been without the support of the trade unions. In fact, the time lost by disputes in most post-war years has been less than the average for the previous decades of the 20th century (see Table 3).

JOINT CONSULTATION

The Coal Mines Nationalisation Act requires the N. C. B. to enter into joint consultation with its employees. At every colliery there is a consultative committee in which the workmen's representatives are elected by secret ballot. The colliery manager is chairman and nominates three colliery officials to be on the committee. There are also consultative councils at the area, divisional and national levels on which the Board and the four main trade unions are represented. Separate but similar arrangements cover manual workers in coke and by-products establishments.

MARKETING

The Board, as the sole producer is bound to make the first sale of coal, whether to a wholesaler, a retailer or direct to the ultimate consumer. Beyond these first sales the Board has no monopoly of distribution though it does act as a wholesaler and has a substantial stake in the retail coal trade in the colliery areas.

It is, however, the policy of the Minister and the Board that the marketing of coal must be controlled centrally. The principal marketing officials of the Board are also Officers of Minister of Fuel and Power's Coal Supplies Organization, whose function is to share out the coal to consumers according to the Minister's determination of the national interest.

PRICES POLICY

The Board has sought to establish a pricing system that is fair, consistent and economically sound. It has improved the sorting and grading of coal, largely by mechanization of cleaning and sorting, and has established pithead prices for each grade of industrial coal based primarily on quality i. e. value in use.

House coal on the other hand is sold retail at zoned delivered prices. For distribution purposes the country is divided into sixty zones; throughout each of these the delivered price of a particular grade of coal is uniform, but it differs from one zone to another to cover differences in transport and distribution costs. The price differentials between grades of delivered house coal, are, however, the same in all zones. The general level of prices is so fixed as to be sufficient to meet the Board's costs in total.

SALES ORGANIZATION

Inland sales were at first handled by the Divisional and Area Offices, responsible for coal production. In 1953 the Board decided to reorganize these arrangements by splitting the inland market into nine sales regions, each with a regional sales office which would control the general flow of coal into the region, co-ordinating all supplies and giving the necessary service to all consumers. These offices now, in fact, sell virtually all the coal going into their regions. Thus the Board's marketing organization is now more closely related to the districts in which the coal is consumed, than to the district where it is produced.

SUPPLY AND DEMAND

Although the level of coal production has risen appreciably since 1946, inland consumption has risen even faster—mainly because of the expansion of industrial output. In consequence, the proportion of output which is exported has greatly declined, compared with pre-war.

Table 4 shows the sources and uses of coal (under broad headings) in 1953, 1954 and 1955.

INLAND CONSUMPTION

Table 5 sets out the inland disposals of coal for the main classes of consumer in each of the years 1947, 1950 and 1955.

In round figures, about 20 per cent of the coal consumed in 1955 was used domestically and collieries, 20 per cent went direct to industry and the remaining 60 per cent went to coke ovens and to public utilities (electricity, gas, railways, and water) and for miscellaneous uses. The coke produced by the ovens is used mainly in the iron and steel industry and much of the combined output of electricity and gas is used industrially. Hence, about half the coal consumed in the United Kingdom is used directly or indirectly in industry.

The trend is for the demand from power-stations to increase in spite of higher efficiency and greater use of alternative energy sources. Coke ovens are also using more. On the other hand demand from railways is falling and will fall more rapidly with the wider use of diesel and electric traction. Collieries also are using less coal as a result of the installation of more economical steam raising plant and conversion to electricity.

The level of inland consumption in any year is greatly affected by weather conditions and by the level of industrial activity. It is also influenced by Government restriction schemes. Coal for domestic use is still limited under the Coal Distribution Order, 1943, by the imposition of 'maximum permitted quantities'. These vary according to the seasons of the year and also between the northern and southern halves of the country.

EXPORTS AND IMPORTS

Since the war there has been a virtually unlimited demand for exports of British coal. Britain has exported all the coal it could spare and has had to balance the needs of overseas customers with the high and rising internal demand. Exports (excluding bunkers) rose from 4.5 million tons in 1946 to 13.9 million tons in 1949. In 1950 there was a slight decline to 13.5 million tons and in 1951 when exports had to be restricted owing to manpower shortages, they declined to 7.8 million tons. Overseas shipments rose in 1952 to 11.7 million tons, in 1955 to nearly 14.0 million tons and in 1954 were 13.7 million. Reckoned by value, exports increased from £9.1 million in 1946 to £50.8 million in 1949, £62.2 million in 1953 and £59.1 million in 1954. In 1955 exports were deliberately cut to 12.2 million tons to reduce the need to import American coal which is expensive and must be paid for in dollars.

The greater part of exports of British coal is sent to Europe, and especially to the Irish Republic, Denmark, Sweden, Germany and Italy. Table 6 shows the quantities of coal exported to different countries in each of the years 1913, 1938, 1946, 1954 and 1955.

Practically all British coal exports since the war are covered by trade agreements and commitments undertaken through the Coal Committee of the Economic Commission for Europe, and the National Coal Board has sought to honour its old customers even when it has meant importing coal at great expense from Europe and the United States and selling at a loss at the prevailing internal prices.

Another factor governing importation of coal has been the need to bring coal by water close to the point where it is required, so relieving congestion on the railways, which at the peak of the winter is very severe. During the winter of 1950—51 the Board imported 1.2 million tons of United States coal and, in addition, about 10,000 tons from India and a similar amount from Nigeria. In 1951–52, 350,000 tons were imported

from India and the United States. In 1953, as an insurance against a shortage of coal during the winter, the Board imported 346,000 tons from France and the Saar, 187,000 tons from Belgium and 24,000 tons from Germany. There were further imports in the winter of 1954/55.

FUEL EFFICIENCY AND SMOKE ABATEMENT

The Government has for a number of years sought to promote efficiency in the use of fuel, among both industrial and domestic users, and has been assisted by various bodies representative of producers and consumers. This campaign is gradually altering the character of demand and is helping to make it easier to meet. It is closely linked with the campaign to reduce smoke, which is wasteful as well as unhealthy and dirty. *The Coal Utilization Council* is financed by the National Coal Board, coal distributors and coal appliance manufacturers and consists of representatives of these interests. It was formed in 1932 to give information and advice on the best use of solid fuel appliances to domestic consumers and retailers of appliances. During the second world war the reduction in coal production and the demands of war industry made economy imperative. When the Ministry of Fuel and Power was formed in 1942, an *Industrial Fuel Advisory Service* with regional branches was incorporated within it. In 1943 the *Women's Advisory Committee on Solid Fuel*, consisting mainly of representatives of appliance manufacturers, women's organizations and others interested in the housewife's point of view on domestic fuel arrangements, was formed to advise women on the use of solid fuel for heating and cooking.

Further measures have been taken during the last four years. Under a scheme introduced in 1952, loans on favourable terms are available from the Exchequer to industrialists for financing approved fuel-saving schemes. In October 1953 a non-profit making company, known as the *National Industrial Fuel Efficiency Service*, sponsored by the British Productivity Council, was formed to promote fuel-saving in industry. The new company, which took over most of the work of the Industrial Fuel Advisory Service of the Ministry of Fuel and Power, came into operation on 1st May 1954. It offers a wide range of advice and services to non-domestic fuel users. The National Coal Board has undertaken to contribute £250,000 a year for the next five years to the new organization and the Central Electricity Authority and the Gas Council have similarly undertaken each to contribute £100,000 a year. The electricity and gas industries, the largest consumers of primary fuel, are succeeding each year in obtaining more energy from each ton of coal they use by increasing the thermal efficiency of their plants.

The Board has a three-fold interest in fuel efficiency and smoke abatement: as a fuel producer, faced with an excessive demand, as an industrial fuel user, especially in colliery boiler plants, and as the landlord of many thousands of domestic fuel users.

In a year the Board produces these quantities of smokeless fuels:

Anthracite Dry Steam Coal	8,000,000 tons
Coke (domestic and industrial)	7,500,000 tons
'Phurnacite' carbonized ovoids	300,000 tons
Gas (sold to Gas Boards)	50,000 million cubic feet.

The Board's development plans provide for expanded production of these fuels, and the Board's Central Research Establishment is concentrating its efforts on finding better processes for making new kinds of smokeless fuel.

As one of the largest single consumers of coal in the country, the Board is doing all it can to bring out greater efficiency in its own boiler plants. About 10 million tons of coal are used every year for steam raising in 4,000 colliery boilers. About 500 of these boilers are Lancashire boilers, of which 2,500 are hand fired. The Board is installing equipment for mechanizing 500 boilers at a cost of more than £700,000—the largest order ever placed for this type of equipment. At the same time, it has introduced control equipment and instruments to increase the efficiency of the plant in use, and has begun a training scheme for its boilermen. An examination and certificate for boilermen has now been instituted by the City and Guilds Institute in London: of the first 116 awards, 107 were to Coal Board students.

Big savings in fuel can be made by electrifying colliery plant and eliminating the direct use of steam, and the Board has continued to instal new electric winders and to convert existing steam-driven engines to electric drive.

During the last few years progress has been made in replacing old and inefficient grates and ranges in some

140,000 houses owned by the Board and many thousand new appliances have been installed. In the new houses being built for mineworkers only approved types of appliances are being installed. Improved insulation to reduce heat losses is also being incorporated in their construction.

FINANCE

The Board is expected to pay its way taking one year with another, but it is not meant to make a profit for the Government. Any losses which it may make it is expected to make good out of profits later; any surplus must be devoted to the objects of the Board as laid down in the Nationalization Act, i. e., the improvement and cheapening of coal supplies, the development of the coal industry and the welfare of the employees in the industry.

COMPENSATION

Persons and corporate bodies whose assets were transferred to the National Coal Board have been compensated. For the purpose of assessing compensation to colliery owners, an independent tribunal made a valuation of the coal-mines as a whole on the basis of their earning power and arrived at a global sum of £165 million which was then apportioned to districts and then to individual undertakings. To this colliery compensation had to be added compensation for ancillary undertakings, for mineral rights owned by the Coal Commission and for special losses caused by the transfer of ownership. The total compensation due from the National Coal Board was estimated at £375 million. Compensation has been paid either in Government stocks or in money; the cost of compensation is being recovered from the National Coal Board by the Ministry of Fuel and Power through funded annuities.

PROFIT AND LOSS

In each year since 1947 the National Coal Board has made an operating profit on the production and sale of coal by-products. In only four years, however, has the Board made a net overall surplus after providing for interest on its debt to the Ministry of Fuel and Power for compensation and money borrowed, for losses on imported coal and for taxation. [1]

In 1954 there was a deficit of £3.5 million and in 1955 of £19.6 million owing to a lag in adjusting prices to the rise in wages and other costs. The cumulative deficit for the whole period 1947—55 amounts to £36.7 million. This deficit is after depreciation provision which has amounted, since vesting day, to about £240 million, so that the Board had in fact some £200 million from its own resources to put towards gross capital expenditure.

CAPITAL DEVELOPMENT

To arrest the decline in the industry, the Board has a long-term programme of reconstruction and development, and had up to the end of 1955 spent about £442 million on capital account. It plans to spend another £1,000 million by 1965. About half the total sum will be on major schemes, new mines or reconstructions, each costing over £250,000. By 1965 it is hoped to produce about 240 million tons with a labour force of 672,000.

Between 1947 and 1949, the first three years of public ownership, the Board invested some £72 million in capital projects in the industry. By the end of 1951 projects had been approved costing £145 million. These investments represented, however, the 'hard core' —i. e., the basic minimum necessary to replace wasting assets and maintain current output of the different kinds of coal.

To decide what investments should be undertaken beyond this basic minimum the Board made a national study of the expected demand for coal in the markets at home and overseas and of the possible ways of meeting it from various sources of supply. Coal produced in one area often 'competed' with coal produced elsewhere and the future of one producing area depended on prospects in others. There had to be a careful weighing up of the possibilities in all the coalfields to ensure that neither too much nor too little capital was invested in any one of them and to avoid a larger surplus or shortage of coal in future years.

THE ORIGINAL PLAN

An overall plan of reconstruction and development was required and, on the basis of a pit by pit survey made in 1948—49, the Board set out its programme of reconstruction for the years 1950—65 in the pamphlet 'Plan for Coal'. In presenting 'Plan for Coal', the Board emphasized its provisional character and the fact that it involved a number of assumptions.

[1] The Board is in principle liable to taxation on its revenue surplus but its actual taxation liabilities are not agreed with the Inland Revenue Department.

The original plan intended to raise production of deep-mine coal from 203 million tons in 1949 to 240 million tons in 1961—65. In order to achieve this large increase in output it was proposed that more than 250 collieries should be reconstructed and that about 20 new large collieries and 50 new surface mines should be opened, that about 250 collieries should remain basically unchanged apart from minor improvements and mechanization, while the remainder would either be closed or absorbed in the reconstruction schemes. It was envisaged that the reconstructed collieries would provide 70 per cent of the necessary output, and that the new collieries and surface mines would provide a further 10 per cent.

In addition to the colliery schemes it was proposed to develop the industry's ancillary activities and services, such as coke-ovens and central workshops.

It was estimated that, when the reconstruction programme had been completed, the industry would require 80,000 fewer mineworkers than the 698,000 employed in 1950, provided that, throughout the period, the men required would be available at the right time and in the right places. This reduction, it was pointed out, would come about mainly by allowing wastage to exceed recruitment over the period.

The Board estimated that the cost of reconstructing the industry during the years 1950 to 1965 would amount to £635 million at mid-1949 prices. Of this sum, £520 million was to be spent on collieries and activities directly associated with collieries,[1] and £115 million on ancillary activities. Just over half the total £635 million was to be spent by the end of 1955.

The Board reckoned that its own internal financing, in particular depreciation allowances, would provide three-quarters of the £635 million required to implement the full plan. The remainder would have to be obtained by borrowings from the Minister of Fuel and Power.

The Board's borrowing powers were raised by the Coal Industry Act 1951, to a total of £300 million, of which not more than £40 million could be borrowed in any one year without Parliamentary permission.

The progress of reconstruction has been somewhat slower than anticipated and the costs somewhat higher, both because of the general rise in wages and prices and of a certain under-estimation of difficulties in the original plan. Of the £442 million (including £69 million spent before 1950) spent on capital account between vesting day on 1st January 1947 and the end of 1955, £128 million was spent on 179 major colliery schemes, each scheduled to cost more than £250,000; £195 million on other capital expenditure at collieries; £25 million on colliery associated activities including health, welfare and research equipment and boring operations; and £74 million on associated development such as coke-ovens and by-product plants, workshops, stores, brickworks, houses, offices and laboratories. Only about half of the capital required had been provided by internal resources and £217 million, out of the £300 million authorized, had been borrowed from the Minister of Fuel and Power by the end of 1955.

THE REVISED PLAN

The Board had made an ad hoc review of production possibilities in 1952 following the publication of the Ridley Report [2] and had decided they might be able to increase output to 250 million tons a year by 1965.

By the autumn of 1955, the Board decided that, in view of their growing experience of the difficulties, costs and problems of reconstruction, the time had arrived for a review of the 1949—50 estimates based on another pit by pit survey. On the basis of this survey they put forward a revised plan which provides for an output of coal from all sources, including opencast, of 228 million tons in 1960 and 240 million tons in 1965. They have calculated that an output of 250 million tons a year cannot be obtained before 1970.

The capital cost of achieving these output figures, and of providing the money for major schemes to be completed after 1965, is estimated at £860 million for collieries and their associated activities. In addition it is proposed to spend £140 million on ancillaries. A total of £590 million will be spent in the next five years and £410 million in 1961—65.

While the revised plan will achieve a substantial increase in the industry's productivity, the present

1 Report of the Committee on National Policy for the Use of Fuel and Power Resources, 1952 (HMSO, Cmd. 8647).

2 These include boring, experimental equipment, medical centres, pithead baths for miners and central washeries for coal.

estimates indicate that corresponding decreases in cost of production will be offset by increased capital charges.

About two-thirds of the colliery expenditure (£860 million) in ten years to the end of 1965 is to be on major schemes (each costing more than £250,000). Out of this sum, £430 million is to be spent on schemes to be completed by 1965, including about a hundred which have not yet been started; £40 million is to be spent on schemes now in progress but which will not be completed by 1965; and a further £ 80 million is to be spent on schemes yet to be started which will not be completed until after 1965—that is to say, there will be £120 million in the 'pipeline' at the end of 1965.

Quite a large proportion of the total investment is on coal preparation plants designed to give the consumer a better product.

The level of capital expenditure for the five years after 1965 can only be indicated on the basis of present knowledge and present prices. The Board's provisional view is that investment in the following five years will not be much lower than the amount they propose to spend in 1961—65. Output from all sources in 1970 might then be about 250 million tons.

The new manpower estimates differ considerably from those of 1950. Instead of the 'Plan for Coal' estimate of 618,000 mineworkers in 1965, the Board now reckon that the industry will require 682,000 with an output per man-year of 319 tons in 1960 and 672,000 with an output per man-year of 342 tons in 1965.

COAL INDUSTRY BILL

A Coal Industry Bill was given a second reading in the United Kingdom House of Commons on 10th May (Hansard Col. 1430). The object of the Bill is to raise the amount which the National Coal Board is authorized to borrow from the Minister of Fuel and Power to £650 million, £350 million more than the present limit of £300 million.

Mr. Aubrey Jones, Minister of Fuel and Power, moved the second reading. He said that he had approved the broad outlines of the NCB plans and estimates, as set forth in their pamphlet 'Investing in Coal'. The detailed estimates involved a number of assumptions but, within those assumptions, had been carefully worked out. They indicated that investment in coal could be effective at a lower capital cost than investment in any other fuel.

RESEARCH AND SCIENTIFIC TESTS

The National Coal Board's Scientific department has two main tasks—to provide a day-to-day scientific service and to carry out research.

The day-to-day scientific service is provided by the divisional and area scientific organizations. Part of the service is to help ensure safety in the mines and to control the quality of coal output. In a year about 400,000 samples of mine air and 1,300,000 of mine dust are analysed. In most areas the properties of coal produced are reviewed every three months; elsewhere there is a full review once a year. Some 300,000 samples are examined in this way every year.

The Coal Survey, which operates from nine laboratories in the coalfields studies the physical and chemical properties of the national coal resources. Examinations are made of seams provided by preliminary boreholes and seams already being worked, and special studies to help with the planning of new collieries and the construction of other collieries are made.

The Board has two central research establishments. The first, which was set up in 1948 at Stoke Orchard, near Cheltenham, Gloucestershire is concerned with research into the treatment and processing of coal. The newer establishment at Isleworth, Middlesex, conducts research into underground mining and mechanical and electrical engineering problems met in the coal industry.

The Board has set up a new research and development establishment—a Central Engineering Department at Bretley, Yorkshire. The first task of this new establishment is the development of new coal face machinery. An almost equally important aim is the development of a fully mechanized support system.

Extra-mural research is also carried out by a number of autonomous research associations including the British Coal Utilization Research Association, the British Coke Research Association and the Coal Tar Research Association. In addition, much of the work of other bodies, such as the Safety in Mines Research Establishment of the Ministry of Fuel and Power and the Fuel Research Station of the Department of Scientific and Industrial Research, is closely related to coal mining.

The total sum spent on research by the NCB in 1955 was about £1 million of which about half was spent at its two main research establishments.

TABLE 2

Recruitment and Wastage, 1953—55

(N.C.B. Mines)

	1953	*1954*	*1955*
Net Recruitment	19,869	20,363	19,661
Newly employed boys (under 18 years)	11,738	16,760	17,157
Newly employed men (18 years or over)	19,997	23,663	24,136
Re-employed			
Total	51,604	60,786	60,954
Net Wastage			
Medical reasons, deaths and retirements	23,105	20,383	21,056
Dismissals	3,953	3,266	2,821
Other wastage	35,437	37,384	42,681
Total	62,495	61,033	66,558
Net change in manpower	−10,891	−247	−5,604

TABLE 3

Stoppages Caused by Industrial Disputes

(Great Britain)

Year	No. of stoppages starting in year	No. of workers directly or in-[1] directly involved	Aggregate duration in working days of all stoppages in year
1900	120	70,000	436,000
1910	209	295,000	5,476,000
1920	213	1,407,000	17,415,000
1925	164	130,000	3,435,000
1930	150	148,600	663,000
1935	217	199,700	1,368,000
1940	381	189,800	506,000
1945	1,306	243,000	641,000
1950	860	141,900	431,000
1951	1,058	134,000	350,000
1952	1,221	273,500	660,000
1953	1,307	168,400	393,000
1954	1,464	204,400	468,000
1955	1,783	353,600	1,112,000

[1] Workers involved in more than one dispute are counted more than once.

TABLE 4

Coal Supplies and Disposals

(Million tons)

	1953	*1954*	*1955*
Sources			
Deep-mined output	212.5	214.0	210.2
Opencast disposals	13.5	10.7	10.5
Import	0.6	3.0	11.5
From colliery stocks	0.5	—	−0.5
Recovered slurry	0.2	0.2	0.5
Total	227.3	227.9	232.2
Uses			
Inland consumption	208.6	213.5	215.3
Exports and bunkers	16.9	16.3	14.2
Changes in distributed stocks (increase +)	+1.8	−1.9	+2.7
Total	227.3	227.9	232.2

TABLE 5

Inland Coal Consumption

	1947	*1950*	*1955* (52 weeks)
Electricity works	27.1	33.0	42.9
Gas works	22.7	26.2	28.0
Railways	14.6	14.5	12.8
Coke ovens	19.8	22.6	27.1
Collieries	11.1	10.7	8.6
Industry	35.8	40.1	40.8
Households	31.6	32.8	32.5
Miners' Coal	5.0	5.0	5.1
Miscellaneous (1)	17.4	17.2	17.5
Total	135.1	202.1	215.3

(1) Includes shipments to Northern Ireland.

TABLE 6

U. K. Exports of Coal

	(million tons)						(million tons)				
	1913	*1938*	*1946*	*1954*	*1955*		*1913*	*1938*	*1946*	*1954*	*1955*
Total exports	73·4	35·9	4·5	13·6	11·7	France	12.8	6.2	·7	1.0	1.0
Of which						Belgium	2.0	0.7	0.2	0.5	0.5
Canada and Newfoundland	0.1	1.3	0.2	0.2	0.2	Portugal	1.2	0.7	0.2	0.3	0.3
Irish Republic		2.5	1.3	1.7	1.7	Spain	2.5	1.0	0.1	0.3	0.1
Sweden	4.6	2.7	0.1	1.1	1.0	Italy	9.6	2.3	.1	1.3	2.7
Norway	2.3	1.4	0.1	0.2	0.2	Egypt	3.2	1.6	0.1	0.0	0.0
Denmark	3.0	3.0	.6	3.4	3.6	Argentina	3.7	2.0	0.0	0.5	0.1
Germany	9.0	3.7	—	1.5	1.1	Brazil	1.9	0.5	0.0	—	—
Netherlands	2.0	0.9	0.1	0.8	0.8	USSR	6.0	—	—	—	—

TABLE 7

THE BRITISH COAL INDUSTRY

the principal statistics

		1938	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
		Private Companies	Private Companies under Government Control	Full State Control under National Coal Board ‡								
SALEABLE OUTPUT :												
Mines	m. tons	277	181.2	187.2	197.6	202.7	204.1	211.9	214.3	212.5	214.0	210.2
Opencast	m. tons	—	8.8	10.2	11.7	12.4	12.2	11.0	12.2	11.7	10.2	11.4
INLAND CONSUMPTION :	m. tons	177.8	186.2	184.7	193.4	195.3	202.1	209.2	208.1	208.5	213.6	215.5
EXPORTS AND BUNKERS :	m. tons	46.3	8.9	5.5	16.3	19.4	17.1	11.7	15.1	16.9	16.2	14.0
MEN ON COLLIERY BOOKS :												
Overall	thous.	781.7	696.7	711.4	724.0	719.5	697.0	698.6	715.8	712.9+	707.2	704.1
Coalface	thous.	Not available	280.2	287.9	292.8	296.2	288.1	287.2	293.6	292.800+	290.400	288.9
OUTPUT PER MANSHIFT :												
Overall	tons	1.14	1.03	1.07	1.11	1.16	1.19	1.21	1.19	1.22+	1.23	1.23
Coalface	tons	3. 0	2.76	2.86	2.92	3.02	3.11	3.17	3.15	3.22+	3.26	3.28
ABSENCE :												
Overall		6. 4	16.0	12.43	11.55	12.34	11.96	12.15	11.23§	12.41+	12.21	12.54
Coalface		Not available	19.3	15.05	14.13	14.94	14.51	14.75	13.67§	14.65+	14.36	14.70
OUTPUT PER MAN PER YEAR :	tons	290	260	263	273	282	293	303	299	298+	303	299
AVERAGE PITHEAD PRICE:	per ton	17s. Od. a ton	38s. 11d.	40s. 3d.	47s. 3d.	47s. 11d.	47s. 10d.	51s. 2d.	57s. 3d.	61s. 2d.	63s. 6d.	68s. Od.
Average Pithead Cost	per ton			41s. 3d.	45s. 7d.	55s. Od.	45s. 5d.	49s. 2d.	56s. 9d.	59s. 2d.	61s. 11d.	67s. 3d.
AVERAGE WEEKLY EARNINGS : (including allowances)		£2.17s. 11d.	£6.3s. 2d.	£6.18s. 9d.	£8.3s. 10d.	£8.14s. 7d.	£9.2s. 4d.	£10.3s. 7d.	£11.5s. Od.	£11.12s. 1d.	£12.5s. 11d.	£13.1s. Od.

‡ Opencast transferred from Minister of Fuel and Power in 1952

§ Absence figures from 1952 are for the 5-day week

\+ = new basis of definition from 1953

TABLE 8

TYPES OF BRITISH COAL

Type	Main Classes of Use according to size: Large	Graded	Small	Current Production (as % of total output)	Source of Supply
1. Anthracite	Special industrial uses, e. g. malting and brewing	Domestic	Steam raising	$1\frac{1}{2}$	South Wales: much smaller amounts from Scotland and North-East Durham
2. Dry Steam Coals	Steam raising	Domestic heating	Steam raising	$2\frac{1}{2}$	South Wales
3. Coking Steam Coals	Steam raising including locomotive	—	Steam raising and corbonisation	$4\frac{1}{2}$	South Wales: small amount from Kent
4. Heat-altered and similar coals: (a) Low-Volatile	Special Industrial uses	Domestic heating	Steam raising	$\frac{1}{2}$	Scotland and Durham
(b) Medium-Volatile	Steam raising	Steam raising	Steam raising	$\frac{1}{2}$	Scotland: very small amounts from South Wales and Durham
5. Medium-Volatile Special Caking Coals	Carbonisation	Carbonisation	Carbonisation	$6\frac{1}{2}$	South Wales, West Durham and Kent: small amount from East Durham, very small amounts from Bristol and Somerset, Scotland and Lancs.
6. High-Volatile Very Strongly Caking Coals:	House and Carbonisation	Carbonisation	Carbonisation	6	Durham, South Wales and Yorks: small amounts from Northerumbland, Lancs, Bristol and Somerset, North Staffs and other coalfields
7. High-Volatile Strongly Caking Coals	House and Carbonisation	Carbonisation	Carbonisation	20	Yorks, Durham, Northumberland, Lancs, Notts and North Derby, North Staffs, Cumberland and South Wales: small amounts from Scotland, North Wales and other coalfields
8. High-Volatile Medium Caking Coals	House, carbonisation and locomotive	Corbonisation steam raising and "producers"	Carbonisation and steam raising	$13\frac{1}{2}$	Yorks, Notts and North Derby, Lancs, Scotland, Northumberland, North Staffs, North Wales and Durham: small amounts from other coalfields
9. High-Volatile Weakly Caking Coals	House, and locomotive	Steam raising and "producers"	Steam raising	$16\frac{1}{2}$	Yorks, Notts and North Derby, Northumberland, Scotland, Lancs and North Staffs: small amounts from other coalfields
10. High-Volatile Very Weakly or Non-Caking Coals	House and steam raising	Steam raising	Steam raising	28	Notts and North Derby, Scotland, Warwicks, Yorks Cannock Chase, Leics, Lancs, South Derby, Northumberland, North Staffs, and South Staffs and Salop

NOTE: "Caking" means become plastic on heating and forming a Coherent residue. Most British coals have this property in greater or less degree. Coals made for making coke suitable for blast furnaces and foundries usually cake strongly; but coke of this kind can also be made from blends of strongly caking coals and others, and not all strongly caking coals make good coking coals. Caking property is also important in coals used for making gas because it has a bearing on the production of coke in gas-works, but the range of caking property can be fairly wide.

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Standardisation of Stores Practices

By A. Deb, B.E.

IN the wake of the Audit report on Defence Stores, suggestions have been put forward in a section of the press for Stores Enquiry Committee. May be, we cannot discuss such suggestion glibly, but it offers an opportunity for introspection. We had in recent years Railways Stores Enquiry Committee, Stores Purchase Committee. Suggestions for another enquiry committee may set all store-keepers a thinking, as to what's wrong.

Stores are sinews of any project or industry. Just as in any house, you can assess the prosperity of the family and the ability of the housewife, by a casual peep in the storeroom, so also in a big establishment, one can assess the shape of things by inspecting the Stores Depot. A capable housewife would arrange her stores in a nice and decent fashion like an artist. She would never allow ants or cockroaches to eat up stuff and would recoup stores just in time, with scientific acumen, so that no one in the family is inconvenienced. A capable store-keeper cannot do more than emulate the ideal of a capable housewife. In his case the constituents are comparable with family members. Heterogenous nature of constituents warrants alertness on Store-keepers. Some have compared store-keepers to fond mothers who keep their babies well fed and always anxious for their progress. Others have compared store-keepers to teeth, service of which is recalled only when it fails to serve. When all teeth are functioning no one thinks of them. With such compliments at their back, store-keepers are a category of people who should never fail in service. Without drawings engineers are blind. Without stores Engineers are lame. Stores are, therefore, sinquanon for the progress and Store-keepers too. With such importance for their service, is there any trend for developing the vocation of Store-keepers? Storekeepers have been declared as technical personnel, but little technical knowledge is now imparted to them. Their know-how has no standard. The primary needs for developing the vocation of Store-keepers cannot therefore be too highly exaggerated.

A store-keeper procures and distributes stores for his constituents. Planning for procurement, inspection of supplies, storage of stock, accounting for expenditure — all these are essential to good storekeeping. The profession of store-keeper demands that an incumbent in the post, like an engineer, knows specifications and methods of inspection of the materials he handles; like an accountant, knows the process of accounting for expenditure; like a scientist, knows how to protect his stock from deterioration, like a factory manager, knows how to handle labour and equipments.

This underlines the need for trained men, as in other countries. But to set standards for the profession, it would be necessary to draw up a syllabus of studies somewhat on these lines:

Basic education—A higher secondary school leaving certificate. Vocational training (a) theoretical: inspection, specification, care of materials, preparation of catalogues, handling of material—six months. (b) practical: ledger-keeping, accountancy, passing of bills, preparation and disposal of vouchers—six months: works training: millwright, toolroom, electric repairs, foundry, smithy—12 months.

Activities of a stores organisation are divided under two main divisions namely Procurement Division and Distribution Division. There are various names or phases in each division but the principle of operation is the same, whether railways, or ordnance or private concern.

The procurement division invests money by purchase of stores for the constituents. The commitments are for and on behalf of the constituents—a fact, very comfortably forgotten by the constituents themselves. It has aptly been said that stores are not only cash in kind but more than this. Cash in bank earns interest but cash in kind depreciates and herein the constituent should bestow a little thought before placing their demand on stores. Critics of stores often find it convenient to forget this aspect. Utility of stores is manifested through transactions and transaction is always bilateral involving store-keeper and consumer. Any criticism on stores is incomplete, if it does not review the performance of the two parties, in the transaction. Should, however, the constituent fail to exert the degree of care expected of them, before they place their indents on stores, the store-keepers should not fail to exercise their prerogatives and revise the indents, for the best interest of the constituent. Of the many ways for prevention of wastage in stores, the first step is the indentor's care and the second step is the store-keeper's scrutiny. The consumer should consume stores according to pre-planned programme, in right time and in right quantity.

Whenever we think of purchases, we take into consideration, the time lag for the purchase and we

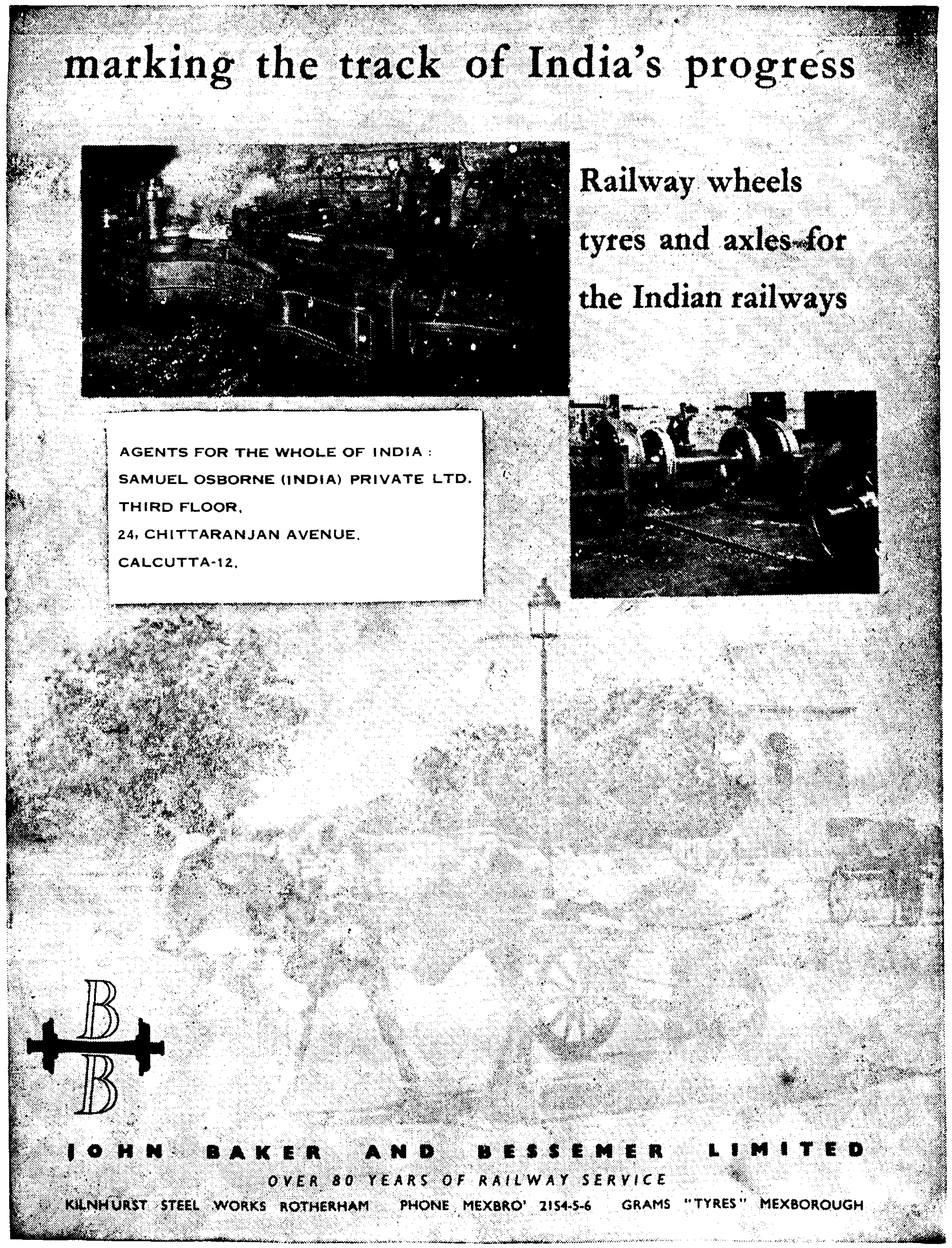
always lay by, the quantity to cover the time lag for purchase. This quantity is called the stores margin in the Ordnance Department and the minimum in the Railway Department. Such fundamental nomenclature should be standardised and more rational one universally adopted. Just as quality control is now a days, indispensable to manufacturer, so also stock control is indispensable to store-keepers and stock control is effected by controlling the stores margin. (Details available in the book 'Stores Manual' by the author). Whether in public sector or in private sector store-keepers should know the technique of stock control by controlling the stores margin and the technique is not difficult to standardise.

Lack of standardisation of stores practice is very apparent among store-keepers of various industries. Even they do not call one item by one name. The Indian Stores Department (W.H.S.) classifies stores according to trade group. The railways classify stores according to purpose. One item thus finds more than one place in stores. How the stores should be classified—whether according to purpose or trade group—should be determined and the standard classification introduced. The Indian Railways may compile one catalogue or catalogues with identical part number and description. Similarly it is for the ordnance to compile one catalogue and items of general purpose stores may again be similar. Nothing will be more helpful to store-keeper than a standard catalogue of stores he holds. The co-operation of Industry is necessary to evolve standard catalogue. The absence of attention in this respect can be illustrated. In the Steel Industry, there is no discrimination between pipes and tubes. What one store-keeper will call pipe, one constituent will call tube and they never know what to indent for or where to look for the stores. Wire, rod, bar, beam, joist are very flexible nomenclature. Compilation of a standard catalogue is, therefore, a herculean task and an impossible task unless the Industries themselves standardise the nomenclature of their products. In the Oil Industry what one calls petrol the other calls aviation spirit. You cannot discern the lubricating oils. Steel and oil have the largest resources and they have scope for research also. But these instances, illustrate the lack of attention, from store-keeper's view. Leave aside the lesser industries where such instances can be multiplied. Should the Industry offer co-ordination in standardising the nomenclature of their product, it would greatly help storekeeping all over the country. If the larger industries take the lead, the smaller one will definitely fall in line. The Indian Standards Institution may also take it on themselves for standardisation of nomenclature of commercial products, keeping in view the store-keeper's predicaments. With the co-ordinating efforts of Industry, I.S.I. and the Store-keepers, it would be possible to relegate the non-standard nomenclatures, now in vogue, in stores. Equally important is the interest of the consumers to know the standard nomenclature and their specification.

It is very common place to comment about wastage in stores. It calls for efforts to evolve means to prevent wastage in stores—effort on the part of consumer as well as on the part of store-keeper. Standardisation of practice can reduce to a great extent the chance of wastage in stores. Standardisation of classification of stores, standardisation of nomenclature of stores are some of the points which should receive the attention of store-keepers and last but not least is the development of vocation itself.

The manufacturer produces stores, whether it is a toy or turbine, and puts up the products in the market. Manufacturing processes culminate in creation of stores. Commercial concerns deal with them to cater for public needs. The laws of demand and supply guide the outturn of stores by manufacturers and procurement by Stores Department. If the stores are given rational nomenclature, then it may attract sufficiently, the attention of consumer. It is not that such attempts are sometimes 'overdone'. Some manufacturer have not yet appreciated the need for interchangeability. In the ball bearing industry, whether the bearing is manufactured in Italy or England or Sweden or India, each manufacturer gives a table showing the corresponding numbers of other makes to facilitate interchangeability. Manufacturers of grinding wheels also furnish tables equating their products to other makes. Makers of tool steel also gives composition of the steel to enable the buyer to select the steel. In the lubricating oil industry, interchangeability of make has not been noticed. However advantageous this may be to the producer, it has no advantage to the consumer beyond binding him to one make and not offering the latitude to interchangeability.

Commercial agents or producers themselves, tender material to the Stores Department against fulfilment of contract. All supplies by contractors are accompanied by a forwarding document which according to commercial terminology is invoice. It is curious that seldom any contractor use the term invoice. They use the term Despatch Memo or Delivery Note or Challan or Packing account or Delivery receipt etc. It passes one's comprehensions why they cannot use one standard nomenclature. Standardisations from Store-keeper's point of view have not yet received the attention it merits in our Industries.



(Continued from page 6)

While one department may be showing record figures what is the position of others? Lack of track renewal has reached a stage that it is likely soon to endanger safeworking. The maintenance of rolling stock is disgraceful and it is purely by good fortune that more accidents do not occur. Drivers are careless and are more concerned about their hours of working rather than their loyalty to the Railway or the public. The out turn of repaired railway rolling stock from Railway Workshops is high but the quality of the repairs leaves much room for improvement. The manufacture of spare parts cannot keep pace with requirements, because the labour works with an eye on the clock and 4 hours of work in a working day of 8½ hours is taken as satisfactory.

It is admitted that difficulties exist such as shortage of raw materials for construction and manufacture, badly trained staff who were recruited during the war without serving an apprenticeship, in experienced supervision and management. But the position during the Second World War was even worse and yet the Railways carried tremendous loads particularly those of the war requirements.

It is no use complaining. It is here that the Administration and Management must show its metal by introducing new plans and ideas which have given results on the Railways abroad. The latest advances in automatic signalling which are capable of increasing the density of traffic per mile of rail are a case in point. As more facilities are given to officers and senior subordinates to go abroad and observe methods and devices which make for higher efficiency in railway working, the best suited ideas could be introduced. As a case in point may be mentioned TWI (Training within Industry), Time and Motion Study, Dieselisation of Locomotives, expansion of electric traction where density of traffic warrants it and finally refresher courses and advanced training for Administrators and Managers with wide vision and clear thinking who are capable of assimilating modern railway advance methods in many directions. We want Administrators with capacity to read foreign technical magazines reporting advances in Transportation, Civil, Mechanical and Electrical Engineering and a mind flexible enough to evaluate their worth, and their introduction on Indian Railways. Indian minds are not noted for originality of thought in the working of railways, but it is no shame to copy. But if we are going to copy let us copy the best which will raise the all round standards so that India may be proud of her Railways and their Administrators and Managers.

U.K. FIRMS DESIGN NEW-TYPE MOTOR-RICKSHA

A new type of motor-ricksha designed jointly by two British firms is attracting considerable interest at the Casablanca International Trade Fair, which opened on May 4.

The ricksha is a three-wheeler employing a motor-cycle-type front end. It has a 350 cc overhead-valve, single-cylinder engine, a four-speed gearbox, and shaft drive to a conventional car-type back axle. It has telescopic suspension at the front and leaf springs at the rear.

The machine, which is being exhibited in three forms—as a chassis, a commercial truck, and a six-seater ricksha—is intended to carry a load of half a ton, and possesses an adequate performance while achieving this. The two manufacturers have produced the vehicle especially to suit conditions in India, Pakistan, Malaya, Viet-Nam, Cambodia, Laos, Hong Kong, and North, South and Central Africa.

The First Indigenous Firm to achieve success in the manufacture of Automotive Diesel Engines

(The world famous PERKINS P6 engines are now in full indigenous production at Madras)

One Hundred and Sixteen years are but a moment in the long history of the ancient land of India.

Travel along any of the shady roads of the mofussil and you may see how short these one Hundred and Sixteen years are, for in the space of an hour or so, the history of road transport in the century rolls before you.

Through the dappled light and shade of the dusty roadway comes the coolie, tramping along on his bare feet, his bundle on his head. Creaking past him in a covered wagon, the bullock driver sits his patient bullocks plodding along slowly with an occasional spasmodic effort at speed as the driver applies his stick or gives their tails a twist. Nearing a temple town, an elephant slouches along the transport of the ancient and still used on occasions of ceremony and splendour. Passing these age old transporters comes the modern streamlined internal combustion engine powered motor coach, speeding along in safety with its passengers. Diesel Trucks also roll along, all these methods of transport linking up village to village.

Shri S Ananthramakrishnan

Mr. A. J. Lund

And so, in a short hour, more than a century's progress in road transport is bridged over, and we see the ancient and modern side by side.

The firm of Simpsons, Madras, has had the proud privilege of living through these one Hundred and Sixteen years of India's life, beginning with the manufacture of the Howdah, Litter and Palanquin, then Travelling Vans, State Carriages, Pony Tongas, Landaus, Victorias, etc., always keeping abreast with improved methods of road transport.

The year 1903 ushered in a new era in road transport in India with the introduction of internal combustion engine propelled vehicles and since that time, the firm specialised in Automobile Engineering, including Motor Car, Motor Coach and Motor Truck body building, in which field they have achieved and maintained an excellent reputation throughout India.

The advent of the Diesel Engine for Road Transport Vehicles was one of the most important developments in recent years and as Simpsons realised the popularity diesel transport would quickly gain, they entered into an agreement with F. Perkins Limited, Peterborough, as Distributors for the whole of India for the famous Perkins "P" Series Diesel Engines. Subsequently, they entered into a manufacturing agreement with the approval of the Government of India, following which a Phased Manufacturing Programme was submitted to the Government of India and on June 5, 1955, the Chairman of Simpson & Co., Ltd., Shri S. Anantharamakrishnan, the noted South Indian industrialist, gave an assurance to Government that by December 1956, i. e., in the remarkably short period of 18 months, Simpson & Co. would achieve complete indigenous manufacture of the Perkins P6 Automotive Diesel Engine to a capacity of 3,000 Engines per annum.

This was a tremendous task and under the able direction and control of the Company's Director & General Manager, Mr. A. J. Lund, a Chartered Engineer, possessing considerable administrative, organising and production ability, the programme was fully completed.

The utmost co-ordination and co-operation of all administrative staff, draughtsmen, jig & tool designers, other technical, managerial and general staff, Workers' Union, and every employee of the Company was most essential for such an undertaking, and it is undoubtedly a great credit to all that a project of such magnitude was accomplished in the very short space of 18 months.

Specifications and capacities of all plant and machinery had to be worked out to suit all machining operations for each and every component part of the Engine. Orders then had to be placed for deliveries Madras to suit the respective phased periods of the Manufacturing Programme. Complete factory layout plans for positioning of the machinery for flow-line production had to be prepared, excavations made and machinery foundations laid ready for installation of machinery on arrival. Additional electric power supply had to be provided including purchase and installation of additional Transformers, new electric power cables and feeder lines together with distribution boards and switch gear. The entire lighting arrangements throughout the factory had to be re-planned.

Jigs, Fixtures and special Toolings had to be designed and manufactured at their Madras Works to the tune of nearly 3 lakhs of rupees value. Simultaneously, necessary labour force had to be trained, especially for the manufacture of high precision work involved in the production of Jigs and Fixtures. And high tribute should be paid to Indian labour for their remarkable adaptability and progress in this specialised sphere of engineering.

SIMPSONS' WORKS

A massive modern construction, double-storied building houses the Administrative Offices, Financial and Cost Accounts, Drawing and Design Office, Sales Department, Central Stores, Purchasing Department, Material Control and Planning Office. And behind this building is the spacious and most modern Workshop. The factory area covers approximately 2,50,000 sq. ft.

THE PERKINS P6 AUTOMOTIVE DIESEL ENGINE

This is a 6-cylinder unit, having cylinder bore 3.1/2" and stroke of 5". Swept volume is 4.73 Litres (288.6 cu inches) and develops a maximum commercial vehicle rating of 83 b. h. p. at 2,400 r. p. m. Maximum torque is 202 lbs. ft. (27.9 Kgms.) The weight of the Engine with electrical starting equipment but without flywheel and starter ring is 696 lbs. In its power range, Perkins P6 is unquestionably the most popular diesel transport engine in the World and in India alone about 40,000 of these engines are operating with extreme reliability and efficiency.

THE MANUFACTURING PLANT

The Perkins P6 Diesel Engine consists of nearly 1,800 component parts, and, of these, 20-odd items are still not manufactured in the country, viz., Proprietary items consisting of Motor Starter, Dynamo, Fuse Box, Venturi, Timing Chain, Starter and Heater Switch Assembly, Etc.

PLANNING FOR PRODUCTION

The organization of the Planning Department has been done on the modern lines, using very extensively the Graphdex Board Charting System and with this the day-to-day stock position of the various engine components and also the flow of the manufacturing programme can be gauged at a glance.

Job Control Boards are operated by the Loading Section of the Planning Office and this method ensures very proper loading of the various production machines and also helps to keep an effective eye on the planned and actual production hours for doing various machining operations. The efficient organization of the Planning Department and co-ordination with the Works and the Cost Office facilitate accuracy in determining the manufactured cost of the component parts day to day.

PLANNING OF CUTTING TOOLS

The various cutting tools required by the Machine Shop are planned and procured, taking into consideration the tool life and the monthly tool consumption. The tools are properly numbered and as per the Operation Sheet, these are stocked in the Tool Stores for easy delivery. The procurement of tools has become a very important function to keep the Machine Shop running uninterruptedly, especially in view of the country-wide shortage of and import restrictions for various cutting tools. In the selection of various cutting tools, factors governing maximum production and tool life, and also the materials to be machined are taken into consideration.

MATERIAL CONTROL DEPARTMENT

The different types of raw materials required for the production of P6 Engines are procured through the Material Control Department. This Department is responsible for the location of suitable materials and ordering them as required. They take very suitable steps to contact various suppliers and ensure that only the right type of material as specified in the designs are procured. All raw materials received at the Works are bonded until material and chemical analyses as required have been taken. This procedure is rigidly followed to ensure that only approved materials to specification are used for the production of the Engine.

This Department also looks after the procurement of various purchased components and also maintains a close liaison with Messrs. F. Perkins Ltd., Peterborough, England, and their Resident Chief Inspector, for obtaining their approval for these items. In the case of completely machined purchase items, a rigorous inspection is instituted in our inward goods section and these goods, like parts manufactured in Simpsons' Works, are constantly under review by F. Perkins Ltd.'s Resident Chief Inspector and his assistants.

MACHINE SHOP

The Machine Shop is broadly divided into two sections: one section manufacturing miscellaneous component parts and the other is laid out for flow-line machining of Cylinder Blocks with Main Bearing Caps, Cylinder Heads, Connecting Rods, Camshafts, Crankshafts, Lubricating Oil Pumps, Water Circulating Pumps, etc. The arrangement of Plant and Equipment has been carried out with a view to obtain a good deal of flexibility in production. Various Capstan Lathes and Automatics have been grouped in one section and several Radial and Pillar Type Drilling Machines in another and in this manner general purpose Milling Machines including Gear Hobbing Machine and SS & SC Lathes have been arranged in different groups.

Four of the Machine Shop bays extend lengthwise within the buildings and this arrangement enables very effective supervision and easy flow of components from machine to machine to be achieved. Manual handling of the components is minimized by necessary mechanization and goods, wherever possible, are palletised and the movement of components at various stages of machining is carried out by the employment of a large variety of specially designed pallets.

CYLINDER BLOCK BAY

The rough castings are delivered at one end of the bay and these are first washed with paraffin in a cleansing tank.

Gravity Roller Conveyors are arranged all along the bay and the castings travel on these from machine to machine, thus reducing to the minimum physical handling. This also helps to avoid 'stock piling' of components on the floor at the various machine stations.

After fettling and washing, the castings are inspected with necessary inspection fixtures to ensure the correct locations of cores, jig location points and machining allowance, and placed on the roller conveyor.

From these the work is loaded directly into the fixture on the first machine, this being a Duplex Miller provided with 2 Nos. 16" dia. inserted tooth carbide cutters. After this operation the work is moved on the roller conveyor to the next operation, i. e., drilling of sump and head faces. In this operation two locating holes are drilled and reamed on the same face for jig location purposes for subsequent operations.

In the Cylinder Block Bay there are several special purpose machines of the modern type such as 6-spindle Snout Borer specially designed for the rough boring of all the cylinder bores, Special Horizontal Drilling Machine for drilling the pressure rail hole in one setting and the wide base Miller for straddle gang milling the Crankshaft bearing sides and alao for form milling the Crankshaft bore. 2 Nos. specially tooled Borematics are stationed for finish boring the parent bore of the Block and the Liners with hydraulically-operated 3 station fixtures. The Honing Machines are positioned next to the Borematics for rough and finish honing the Cylinder bores after finish machining of the Liners.

Most of the other operations are carried out on general purpose machines including Radial Drilling Machines, Vertical and Horizontal Milling Machines, Radial Arm Tappers, etc. All machines have been tooled up for doing particular operations through suitably designed jigs and fixtures.

The Crankshaft and Camshaft bores are finish bored in a Horizontal Boring Machine after fitting the main bearing caps which are processed alongside the Block and brought over to a fitting station. When the machining operations on the Block are completed, the Main Bearings are fitted and line bored.

At every stage of machining, strict inspection is maintained by well trained stage Inspectors to ensure that only correctly machined Blocks are allowed to move forward to their next operations.

Before line boring the Blocks these are water tested and also the pressure rail paraffin tested to ensure that the Blocks are leakproof in every respect.

Completely machined Cylinder Blocks before delivery for assembly are inspected by Final Inspection Department, although rigid stage inspection has already been done at different stages of production.

CYLINDER HEAD BAY

The various machines for processing this component are arranged operation-wise. The rough castings are fed from one end and the completely machined heads are delivered to assembly from the other end. The work travels on roller conveyors and arrangements have been provided for lifting the work from machine to conveyor and conveyor to machine with the help of overhead lifting gear. For the machining of Cylinder Heads Vertical Milling Machines, Radial Drills, Radial Arm Tapping Machines, etc., are used, all of which are specially tooled and jigged for rapid production and interchangeability of the component. As in the case of Cylinder Block, rigid stage inspection is maintained and the completely machined Heads are delivered to Assembly only after passing 100% final inspection.

Before commencing the first machining operation, the castings are thoroughly inspected on the production line itself for jig location points, machining allowance and to detect any casting defects.

After completing the machining operation, the Heads are also hydraulically tested and steam-cleaned.

CONNECTING ROD AND CAMSHAFT BAY

The Connecting Rod stampings, made out of Nickel Chrome Molybdenum steel, are first inspected very thoroughly in the materials inspecting wing of the Inspection Department to detect twists and other stamping flaws. Only approved stampings are then released to the production line and before the commencement of the first machining operation, the stampings are fettled and crack detected on a Magnetic Crack Detector.

In this bay also the machines are stationed on operation basis and, therefore, the Connecting Rods move from one machine to the other in perfect sequence resulting in the least amount of handling.

Specially designed pallets are used for this bay instead of roller conveyors and the components are placed vertically on these pallets by the operative after completion of each operation.

The various milling operations are done by employing negative rake milling cutters as the material has over 65 tons tensile strength.

After the rods are completely machined, steel backed small-end bush is press fitted and then finish bored to size on a precision specially-tooled Fine Borer. On completion of all operations the rods are again crack detected and demagnetised before delivery to final inspection where these are individually weighed and matched. Specially trained Stage Inspectors vigilantly watch for any process variation at different stages of production.

P6 Engine Camshafts are machined on journals which are ground to micro-finish. The Cam Lifts are profile ground and a specially designed Cam-o-matic Grinding Machine, specially tooled, give correct profile of all cam lifts. Cam contour and respective cam lifts are checked on a specially designed fixture during process of manufacture.

CRANKSHAFT

The P6 Crankshaft is machined from high tensile Nickel Chrome Molybdenum steel drop forgings. This most important component has been tooled up with utmost care as the efficient performance of the P6 Engine depends to a very great extent on the precision of the Crankshaft.

Most modern equipment is installed for the production of Crankshafts, the general sequence being crack detection of Crankshafts before passing into Machine Shop, centering for turning operations, rough and finish turning main bearing journals and crank pin journals, rough grinding all journals, drilling lubrication oil holes, induction hardening all journals by a special induction hardening plant, tempering after hardening, finish-grinding, balancing the Crankshafts and final crack-detection before being passed for assembly. Very rigid inspection is employed throughout the various machining and grinding stages and 100% inspection is carried out after all the operations have been completed.

GENERAL SECTION

In the General Section in the Machine Shop, various component parts such as Water Pump, Fuel Pump Drive, Lubricating Oil Pump, Starter Ring, Timing Case, Exhaust and Induction Manifold, Sprockets, etc. are manufactured. The Starter Rings are electrically butt-welded and passed through the Crack Detector before going forward for machining and cutting of teeth. The Starter Rings are again crack detected before 100% final inspection and utilisation in assembly.

Two special Hobbing Machines are utilised for cutting teeth in all Chain Sprockets, Spiral Gears, and all gears are tested by means of a Goulder Gear Testing Machine fitted with chromium plated master gears.

TOOL ROOM

The Tool Room is equipped with excellent high precision machinery, including a Jig Borer. Special grinding machines are used for maintaining necessary supplies of correctly ground milling cutters, reamers, drills, taps and other small tools. All jigs and fixtures are periodically checked for wear and are carefully maintained to ensure absolute interchangeability and maintenance of very close machining tolerances.

ASSEMBLY OF ENGINES AND
TESTING OF ENGINES

The Engines are assembled in the well laid out Assembly Section on a line assembly basis and every Engine, after complete assembly, is subjected to very rigorous functional tests utilising Hydraulic Dynamometers. Fuel and Lubricating Oil Consumption figures are checked to ensure that each and every Engine complies with the very rigid standards laid down. Each engine averages 5 to 6 hours of actual functional test. After test, each and every Engine is very carefully examined, after finish painting and packing prior to despatch from the Works.

The production of an automotive type diesel engine of the Perkins P6 type calls for very efficient technical planning, extreme skill and supervision and also the adoption of modern production methods. The Perkins P6 Engine is world famous for its simplicity, rigidity, accessibility, economy and high quality, and Simpsons have taken every care to ensure that each and every component fitted into the Madras-manufactured Engine is, in every respect, equal to, if not better than, the previously imported product. From the manner in which the various machining operations on the several components of the Engine are produced in Madras and the excellent administrative co-ordination, one can very boldly state that the Perkins Engine being produced in Madras is not, in any way, inferior to the foreign product.

A Wagon Every 20 Seconds — India's Largest Rail Yard Creates A Record

India's largest railway marshalling yard at Moghalsarai, near Banaras, in April set up a record of operating performance, which has never before been achieved in its long history.

Daily during March, an average of 2,082 wagons were despatched to a multitude of destinations on the Northern, Central and Western Railways, marking a 17 per cent increase over the performance in March last year, and a 24 per cent increase over March 1955.

In the opposite direction to the Eastern Railway an average of 2,101 wagons left Moghalsarai daily during March, an increase of nearly 20 per cent over the daily average for March last year.

During the last 11 days of March, an average of one wagon left Moghalsarai every 20 seconds. This process continued all round the clock.

Power Cars for Indian Railways All Air-Conditioned Trains

By A. C. Bhattacharya, A. M. I. Prod. E.

THE introduction of all air-conditioned trains on Indian Railways is a big step forward in travel comfort. They give experience that enriches life making the travelling public participate in a sort of railway rhapsody.

This is the first application in India of air-conditioning to a complete train including third class and restaurant cars and is a symbol of the progressive spirit of Indian Railways.

Each train is made up of two luggage, brake and Power Cars (one at either end), one first class sleeping car, one restaurant car and three third class chair cars making a total of seven coaches per rake.

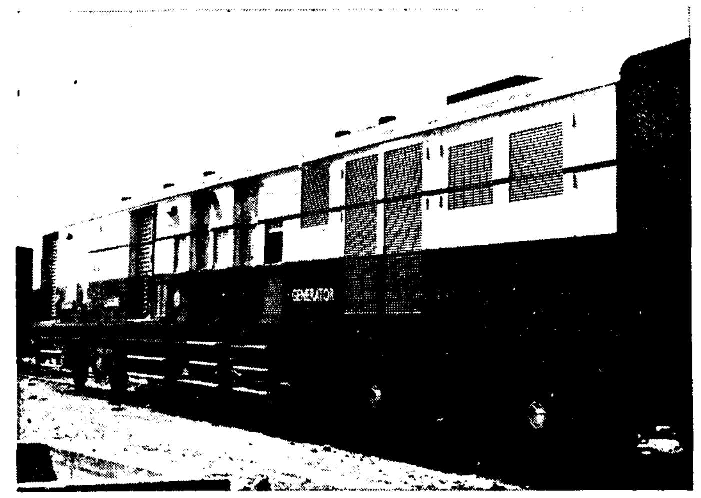
The air-conditioning of an entire train requires large amounts of electric power and the principle of 'end-on' generation has been applied in this case. The arrangement supplies 400 volts, 50 cycles, 3 phase A. C. supply for the air-conditioning equipment and 110 volts, 50 cycles A. C. Supply for use in compartments for lights, fans, kitchen appliances, etc.

The generation and distribution of this electric power calls for highly specialised knowledge and new methods and equipments. The main equipment is housed in the luggage, brake and power car, six of which have already been constructed and two are still under construction in the Eastern Railway Workshops at Kanchrapara. The cars built are of entirely new design and are the first of their kinds ever constructed in Indian Railway Workshops.

The equipment has been supplied by J. Stone & Co., who were also responsible for the installation of the air-conditioning plant in all the coaches of these trains. The Power cars are, however, not air-conditioned.

The principal dimensions of the car is as follows:

Length over buffers	72 ft. 2 in.
Length over headstocks	68 ft.
Width over bodyside panels	10 ft. 8 in.
Gauge	5 ft. 6 in.
Tare weight with fuel oil	56 Tons.



Exterior view of the power car.

LAY OUT

The lay out incorporates two luggage compartments at one end with the fuel tank chamber in between and the power compartment on the other end to house the generating equipments, alternators, switch gears, etc. This end is vestibuled.

Location of the fuel tanks within a separate compartment between the luggage compartments was arranged to give the most even weight distribution on bogie loading and also to obviate any fire risk from hot pit ashes. As a further safeguard all wooden members underneath the coach that are exposed around this compartment have been covered up with aluminium sheets and painted with fire resisting paint.

In the centre of the vehicle is located the guard's compartment and a small compartment for the staff who will attend on the generating equipments. Attached to the staff compartment is also a lavatory for use of the staff.

A 2 in. partition across the power compartment divides it into two sections, one housing the engine units, radiators and auxiliary fuel tanks, while the other containing the alternators and electric switchgears. This arrangement enables filtered air to be drawn into the electrical section of the compartments by means of the alternator fans and thus keeps that portion of the Power Compartment clean. Self-closing intercommunication door with transparent glass panels has been provided on the partition between the engine and alternator compartments. A chequered plate flooring has been fitted inside the power compartment centrally between the engines and also the alternators to provide the gangway leading to the vestibule.

The staff compartment has a 3-tier arrangements of berth, a table and a shelf. The lavatory has all fittings prescribed in the amenity standards for lower class coaches. The guard's compartment has similarly all accessories as are usually in vogue.

The bottom edges of the windows are located 2 ft. 6 in. from floor height and the window opening is 22 in. high. All window openings are 2 ft. wide. The shutters in these windows are the standard 'lift-to-open' type.

The Power compartment is fitted with body side aluminium louvred doors covered by wire mesh to allow a free exchange of air by normal ventilation. The sizes of these doors are comparatively larger to facilitate removal of the generating sets for servicing and repair. A work bench is placed inside this compartment. The engines and the alternators are positioned in the compartment in relation to the centre line of the bogie both longitudinally and transversely.

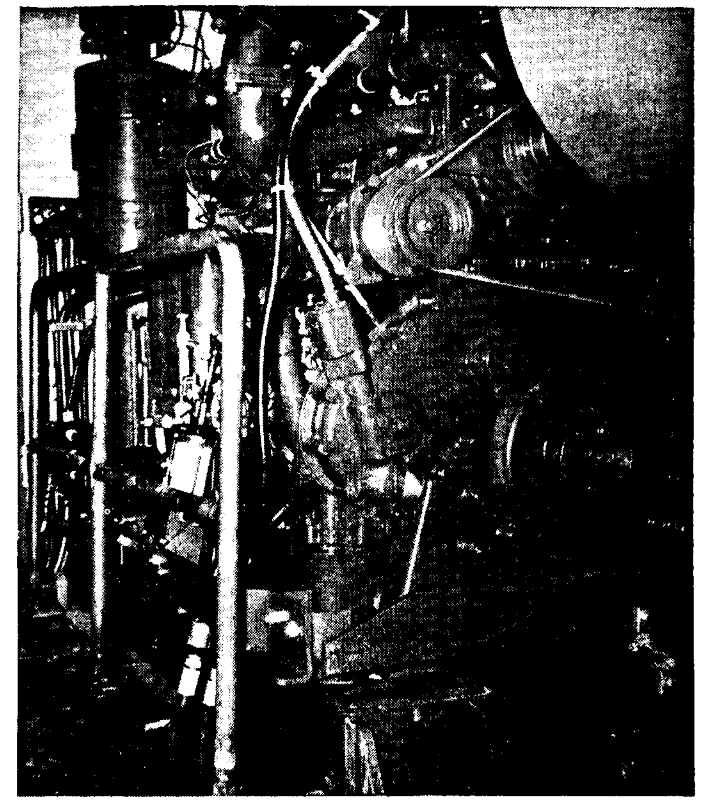
The power switch panels are arranged at one end of the electrical section of the power compartment where they are housed in suitable cupboards.

To match with other coaches to form the complete rake, the roof profile is of the raised type and a height of 13 ft. 0½ in. from the rail level to the top of the roof has been worked to while constructing these coaches.

The arrangements of the baggage compartments are of standard pattern with all steel sliding doors and luggage racks. The carrying capacity of each of these compartments is 2½ tons. For stable running and equal load distribution over the underframes and springs, the compartments have been ballasted with 4 tons of cast iron ballast weights suitably applied.

UNDERFRAMES & BOGIES

The underframes used are of Indian Railways standard mild steel type and the bogies are made up of high tensile steel sections and plates. FAG cylindrical type roller bearing axle boxes are fitted to these bogies.



Close up view of the engine unit.

In view of the higher tare weights of the coaches, the following modifications had to be done to withstand the dynamic loading.

1. Camber of the underframe was increased from 1½" to 2½". Existing truss angles of 3½"×3½"×½" was replaced by 4"×4"×½" size.

2. Bolster arrangements altered by providing six nests of bolster springs comprising two in each per bogie in place of the conventional type of four nests of springs consisting of three springs in each to increase the bolster spring capacity. The other alteration made was to strengthen the bolster spring planks by manufacturing them from 6"×6"×5/8" angles suitably cut for the fitting of the rocker bar seating. This arrangement provided the clear space for the free movement of the anchor pins for Andre shock absorbers fitted on the bolsters.

3. Standard 10 plated springs were replaced by 11 plated bearing springs manufactured from 4"×5/8" spring steel flats. The auxiliary springs were also similarly replaced by helical steel springs in nests of two in each having higher load carrying capacity.

Engine Unit in the Power Car.

4. The fixed type bolster hangers were dispensed with and in their places adjustable type bolster suspension links were fitted. This was done for maintaining the fundamental clearance of 2½" between the bogie sole plate angle and the underframe transom and for obtaining the required buffer heights. In order to ensure, however, that such clearance and required buffer heights may be obtained without excessive tightening of the adjustable nuts, 1 in. thick timber packings with ½ in. thick mild steel plates on them were introduced below the bolster springs seat plates. It is a well known fact that for good riding of heavy coaches, it is essential that full advantage is taken of the standard effective length of the bolster swing links. Excessive tightening of the nuts shortens this effective length with consequent increase in the periodicity of lateral movements and sets up thereby a high frequency roll. The introduction of these packing had another advantage in that they provided the clearance required between the lateral shock absorber suspension and the bolster spring plank and also ensured centre distances of the vertical type Woodhead Monrœ shock absorbers being kept at 16.5/8 in.

The spring gear on the power cars was designed to obtain a natural frequency from the bogie bolster springs between 110 and 118 cycles per minute and an over-all natural frequency of the entire springing system of about 70 cycles per minute.

Other modifications carried out to the underframes owing to the location of the guard's compartment in the centre and for taking the generator equipments are as follows: (a) hand brake column shifted with necessary alterations to a few hand brake parts, (b) shifting of the train pipe, (c) provision of the trimmer and gusset for the fitting of the bell crank lever, (d) fixing 16 ft. × 9 ft. 3 in. × 5/16 in. mild steel plate on the underframe on the generator end with the removal of the existing top gusset coming on the way, (e) provision of additional angle trimmers for the transformer and radiator mountings, (f) fitting of robust type body brackets of supporting the extension beams for sliding the engine and alternator in and out, etc.

SPECIAL BRAKE RIGGING

These power cars are to run with high speed trains. Bearing in mind that the speed of a train is governed by its ability to stop, it was thought proper to improve the mechanical advantage of the brake rigging so as to raise the brake pressure from a mean value of approximately 36 tons to approximately 45 tons per coach by fitting a revised brake rigging in these cars with an increase in the maximum permissible piston travel to the extent of 6 in., and also by making provision of fitting automatic slack adjusters at a later date on receipt of their supply to give greater reliability and safety.

This entailed modification to the following standard brake parts: brake shaft pull rod arm, brake connecting link short, brake beam and brake vertical lever. The modifications done were in making them stronger to withstand the braking load.

The slack adjusters to be fitted as a trial measure on these power cars are to be of Stopex type, Gresham G. D. type and Westinghouse's Weslak type in three sets of the Power Cars forming three trains.

For efficient braking, Direct Admission Valves have been fitted in these cars. These valves are to ensure

quick admission of air to the brake cylinders, and thus reduce the time lag in the brake application. The principle employed is that air entering the train pipe actuates the D. A. Valves and not the brake cylinder. Air direct from the atmosphere enters the brake cylinder through the direct admission valve, i. e., each brake cylinder has an independent air supply from the atmosphere, as a result of which the operation of the brake gear is speeded up in consequence.

POWER INSTALLATION

The power installation in each power car comprises two generator sets and consists principally of the following equipments—Diesel Engines of the Rolls-Royce type C. 6. SFL Model 131 B series supercharged developing 200 H. P. at 1500 R. P. M., 'Tonum' Alternator-Exciter sets of J. Stone & Co.'s manufacture having a capacity of 165 KVA with starter motor and exciter, Radiator and its fan with motor and A. C. contactors, Starter Battery of the lead acid type with transformer rectifier charger unit with ammeter for 24 nominal volts, Silencer, the exhaust, air filters, differential current transformers and a set of switch gear. The other equipments include tanks for fuel oil, inter-car couplings, Holset couplers between the engine and the alternator, engine control gear and supporting beam, puralators, water trap and stop cock assembly, radiator anti-vibration mountings, etc.

The attendant switch gear includes main and feeder control panels, master feeder line controller, automatic exciter and stabiliser regulator unit, automatic synchronising and load sharing apparatus, engine and alternator instrument panels for both engine and exciter control, and engine protection devices consisting of low oil pressure cut-out and indicator light, low water level cut-out and indicator light, water temperature cut-out and indicator light, pilot lights for 'fuel-on' and 'starting', 'Stop' push button with Mushroom Head and fuel control solenoid.

The engines are connected to the alternators through a "Holset" flexible coupling combined with a Hardy—spicer telescopic propeller shaft for reasons of simplicity with which either the engine or the alternator may be disconnected from each other for periodic servicing and repair without disturbing in any way the electrical installation. This arrangements also ensures the reasonable mal-alignment between the two units can easily be accommodated.

The electrical load of the train is divided between two separate groups of feeders running along each side of the coaches. Under normal full load conditions the two alternators may be run in parallel but with light loads one alternator can be arranged to supply both sets of feeders. When operating in parallel, load sharing can be effected automatically by governor servo motors acting upon the mechanical governors of the diesel engines in response to a 'signal' current received from a differential wattmeter. The same servo motors can be employed for the purpose of frequency control.

Engine starting is accomplished with the help of an axial type starter motor which provides the initial starting torque by engaging itself with the flywheel. A push button control panel installed in the electrical section of the generator compartment of the power car, controls the actual starting and stopping operation.

The starter motor and control circuit derive power from the 24 volt starter battery which remains in a charged condition by the battery charger unit of the transformer—rectifier type connected by means of switches to the main AC bus-bars.

EQUIPMENT MOUNTINGS

The engines are mounted on fabricated frames with suitable anti-vibration mountings arranged between the frames and the engines at each of the corners. The engine frames are in turn supported on two transverse runner members made up of 8"×6" beams with machined top seating faces. These beams are complete with the brackets incorporating the devices for aligning the engine with the alternator. To these runners extensions can be bolted. These extensions are to extend outside the Car through the side doors and be supported on trestles. This arrangement enables the engine to be slid out sideways into the open where it can be lifted from the runner extensions by means of suitable lifting tackle and obviates the necessity for providing roof traps in the power compartment.

For draining the sumps with the engines in situ, suitable apertures have been provided in the Car floor. These apertures are covered by means of trays which are bolted on to the floor plate and meant for collecting any oil spillage. For manoeuvring the engines into position on the runners, jacking screws are provided to simplify the lining up of the four bolts which secure the engine sub-frame to the runners.

The scheme for mounting the alternators is generally similar to that described earlier for the engines. This also takes the form of two transverse members which in this case are 9" × 3" channel sections. They have machined pad surfaces to take on the alternator. Suitable jacking screws with their appropriate supports are incorporated in them for alternator alignment. A collapsible bellow connection between the floor and the alternator discharge outlet has been provided.

Radiators are mounted separately from the engine and have their own electrically driven fans which draw air from the outside of the car through suitable louvres and discharge the same through the roof. As the limitations of the gauge do not permit the inclusion of water proof cowls in the roof of the car, the top of the ducts has been left open and provision has been made at the bottom of the ducts to drain off rain water to the underframe. The radiator arrangement prevent hot air being blown into the power compartment. The radiator rests on rubber pads which sit on a longitudinal angle member forming part of the main supporting framework built up of angle sections.

The motors driving the fans are fully accessible through the louvred openings in the side walls of the Car and have the advantage of the streams of air at outside temperature being drawn through the body side and blown through the radiator coils. The switch gear for the power units have been kept separated as far as possible. In each case the alternator and the feeder control unit is accommodated on a steel framework above the alternator and supported from the underframe. Each steel framework contains three main panels — (a) Alternator inter-locking panel including radiator fan contactor, (b) alternator power panel mounting the main alternator contactor and protective devices and (c) the feeder power panel incorporating feeder contactor and protective devices.

The Isolating Link Box is mounted on a sub-frame between the two main alternator panels. The synchronising and load sharing panel together with differential current transformer is mounted on the electrical side of the partition between the engine compartment and the electrical compartment. The engine instrument panels are mounted on the engine room side of the partition with the projection which accommodates the dials projecting through the partition, so that they are visible from the electrical side. The battery junction box is accommodated under the cat walk between the engines in the engine compartment and is accessible through an enlarged cover plate in the cat-walk which also provides access to the bogie king pin. This junction box is the means of accommodating the main leads from the battery, the two starter isolating switches, from the battery charger and also the various leads which take their feed from the battery.

The warning and Indicator lights panel is accommodated over the door in the end bulk head of the electrical compartment. The battery charger rests on the floor against the end bulk head on the side of one of the power units. Other equipments for the generators like exciter control panel, stabiliser panel, reverse power relay, instrument panel are mounted inside the end bulk head of the electrical compartment.

SILENCER AND EXHAUST ARRANGEMENTS

The silencer and exhaust arrangements have been made in the centre of the roof to take advantage of the narrow extension of the loading gauge. Each silencer is accommodated within a protective cylinder which is open at the bottom and top to provide a free circuit of air for cooling and which automatically aids the ventilation of the engine Compartment.

A hood has been provided above the engine duct surrounding the silencer and cowl above the exhaust fishtail. The exhaust gases from the engine are taken through flexible piping and silencer straight to the roof and provision has been made to ensure against blow back and reverse draught to the engine compartment.

FUELING AND LUBRICATING

The fuel storage capacity provided in each power car is 520 gallons viz: 400 gallons in two main tanks and 120 gallons in two auxiliary tanks. This quantity is considered sufficient for 30 hours run on the basis of the estimated consumption of 8.4 gallons per hour per engine or 16.8 gallons per hour per power car. Facilities have been provided for filling the fuel tanks from either side of the vehicle, an equalising pipe being fitted between them.

Each tank is separately vented with a 3/4" pipe to roof level. A 3/4" O. S. dia. 16 Gauge Wall thickness copper pipe connection ensures supply of fuel oil from the main tanks to the auxiliary tanks. Stop cocks are provided to cut off fuel supply in the event of a damaged fuel pipe or other emergency.

The feed to the engine is taken from a 3/4"/3/8" tee at the lowest level in the main pipe line through the puralator and water trap assembly via a suitable flexible fuel pipe connection to the engine mounting. There is also a fuel spill over return pipe from the engine to the breather pipe of the auxiliary fuel tank.

Each of the main fuel tanks is provided with a mechanically operated fuel gauge and in addition an electrical gauge with remote indicators in the power compartment. The electrical gauge indicates only when the engines are in operation.

Each engine requires 1/2 pint of lubricating oil per hour en-route for topping up.

FIRE EXTINGUISHING

To meet fire accidents, each power car is provided with three different types of fire extinguishers, viz: Soda-acid type, foam type and C. T. C. type, the latter two types being suitable for application against fire from oil & petrol and electric current respectively.

Because of the particular technical characteristics being required and the operating environment being different from other standard coaches, special attention has had to be paid to the constructional features and exterior finish of these power cars.

To improve riding qualities of these Cars, provision has been made for fitting 'Andre' shock absorbers to arrest lateral oscillations and 'Manroe' shock absorbers for controlling the vertical movements.

Aluminium alloy sheets 3/32" thick have been used for exterior panels throughout the coaches while the interior panelling in the guard's staff and engine compartments is of 3/8" plywood construction. To reduce the body weight, timber framings are all in first class Burma teak. Ceiling panels are of 1/8" plywood boards.

Basic colour schemes are white mat finish ceiling and enamel buff interior. The finish of the exterior is carried out in two shades with a green border line running over the windows. The lower panels below the waist rail have been painted in either Gulfred, Brunswick green or Royal blue depending on the regional operation areas to be served by them, while the top panels are painted in pale cream.

Planning and forthright execution of this programme which largely caters to the comfort of the travelling public, only indicates that Indian Railways are moving forward at unprecedented speed, entering new areas of development which were until now considered the preserves of more advanced railways in other countries.

ACKNOWLEDGEMENT

The author is indebted to Mr. D. J. Batliwala, Deputy Chief Mechanical Engineer/Shops, Eastern Railway, Kanchrapara for his kind permission to publish this article and reproduce the photographs showing the different views of the cars built.

SPOT-WELDING SPEEDS CAR RENOVATION

THE New York Central Railroad is completely renovating the stainless steel fluted siding on 150 streamlined passengers cars at its shops at Beech Grove. The reconditioning process, which includes removing the siding from the cars, cleaning the strips separately and spot-welding it back in place is expected to add years of extra life to the cars, in addition to putting their exteriors in "like-new" condition.

The well-organised reconditioning procedure begins by removing the siding as carefully as possible to prevent any damage. All reclaimable strips are then cleaned at the weld area by a specially-built machine. As the 70-ft. strips pass through the device at high speed two wire brushes clean them on both sides.

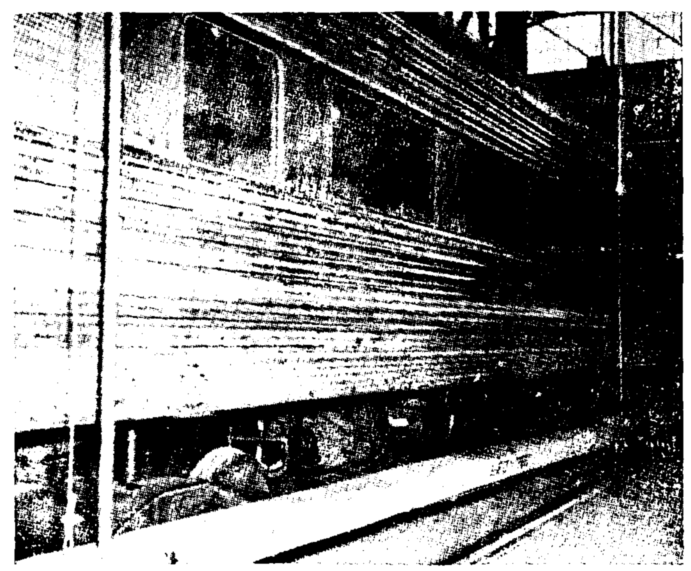
The clean strips are reassembled on a $\frac{3}{4}$-in. cambered table. Seven strips make up the lower section of the car side, and four strips the section above the windows. The strips are assembled by spot-welding with a "Heliarc" HW-8 portable gun, using 1/8-in electrode. Shielding argon flows at 25 cu. ft. per hour; about two cylinders of argon are needed for three cars.

The operator begins his work by spot-welding one end of the assembly together, followed by a number of welds spaced in the middle of the section, and at the opposite end. He then works back to spot-weld the remaining spaces together along the section. A bottom section requires 1550 spot-welds, while a top section requires 980 spot-welds to join it together.

1. RECLAIMABLE strips are cleaned at weld area as they are propelled between wire brushes in specially-built machine.

2. SPOT-WELDING is started at one end, followed by more welds in the middle of section and then at the other end. Spot-welds are then made in remaining spaces.

3. SECTIONS are assembled on a long bench which is cambered 3/4-in. Narrow top section requires 980 spot-welds and wider lower section of siding needs 1550.



AFTER a thorough polishing, the re-applied stainless-steel siding will look like new. Exterior reconditioning adds extra years of usefulness to NYC's passenger cars.

4. NEW stainless-steel channels, for application of siding, are arc-welded to side of car. The car sides are then sand-blasted and given a prime coat of paint.

5. TWO MEN are able to apply assembled sections of siding to car. One man holds strip in position with a lever, while the other man spot-welds it to the channel.

While this work is being done, new 1/16-in. stainless steel channels are arc-welded to the sides of the car. The car sides are then sandblasted and prime-coated in preparation for the sheathing.

Two men handle the job of applying the sections of welded siding to the cars very efficiently. One man, with the help of a simple lever, holds the section of siding in place against the car while another man spotwelds the stainless-steel sheathing to the new channels. The entire bottom section requires 300 spot-welds in this operation, while the top section requires 225.

After the fluted sheathing has been applied to the car, lengths of 3/16-in. snap-on mouldings are put in place, covering the weld seams. The car is then given a thorough polishing and is returned to service.

MANUFACTURE OF INSULATORS

The Government of Andhra Pradesh is reported to be planning for manufacturing insulators to be used in electrical undertakings at their ceramic factory in Guntur where a tunnel-Kiln is proposed to be set up to manufacture special varieties of ceramic articles, including electric insulators. The cost of the scheme has been estimated at Rs. 10 lakhs and regular production is expected to commence in about a year's time.

RUBBER IN OVERHEAD RAILWAYS

BOTH in England and the U.S.A., interest is being revived in high speed overhead railways as a means of solving traffic congestion and as in all really modern forms of transport, rubber is playing a vital part, both in the form of rubber tyres and as units of suspension.

The famous overhead railway at Uppertal in Germany which has been in operation for over half a century formed the basis for the design of a full scale model overhead railway built earlier this year in a part at Houston, Texas. In this ambitious model over a 970-ft. freeway, an oval shaped 50-ft. coach equipped with 28 pneumatic tyres was suspended 18 ft. above the ground. Although limited to moderate speeds by the comparatively short rail length, the car is claimed to have a high potential speed on long runs. Eight 8.25–15 Traction Hi-miler tyres built by Goodyear carried the load and provided traction, and another series of twenty 4.00–8 Goodyear rib trailer tyres served as guide tyres.

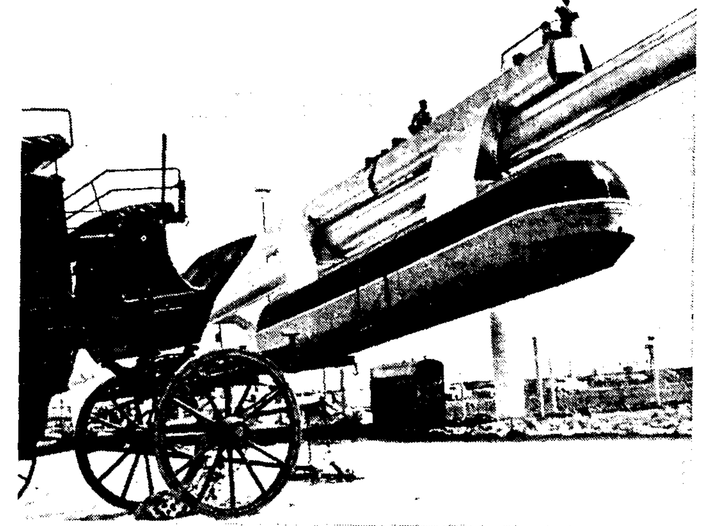


Fig. 1. An old-time stage coach contrasts strongely with the suspended coach of the new Houston Skyway Monorail underneath its single overhead rail.

A working scale model based on the same principle but of a new design was exhibited in England last autumn by International Monorail Ltd. This organization has been working on methods of traction for the proposed overhead route from Earl's court to London Airport, which has been arousing considerable interest in transport circles.

In the International Monorail design, the pneumatic tyred bogies run inside a steel box girder. A split on the lower side of the box provides a passage for suspension gear between the bogie and the car body.

The advantages of the split box girder type of construction have been enumerated in an article on the subject in " Modern Transport " as follows :

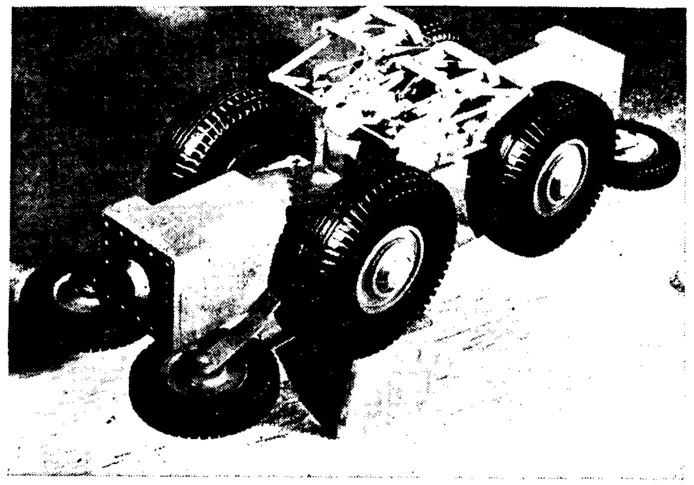
" (1) The bogies and the electric motor are placed in the interior of the split rail and are invisible from the outside. They are protected from the weather as are the wheel tracks and the electric conductors.

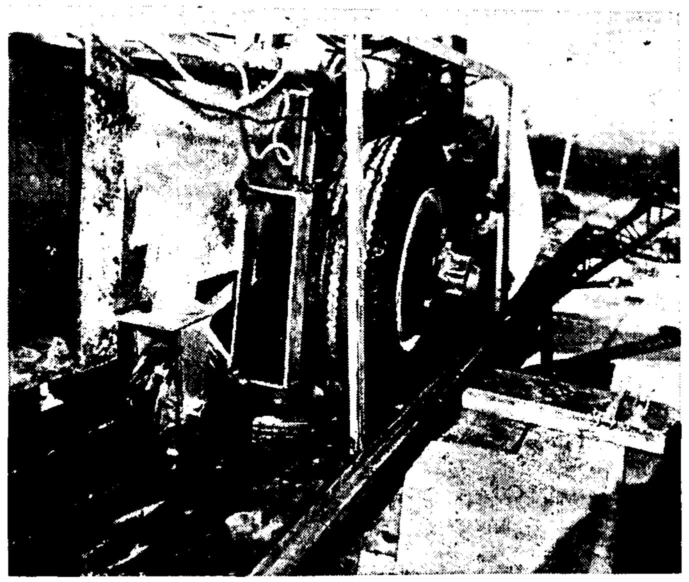
(2) The vehicle being freely suspended on the bogie, the centre of gravity is always situated within the axis of the girder.

(3) The design of points and crossings is relatively simple and claimed to be comparable with that of orthodox railways. "

INTERNATIONAL MONORAIL LIMITED.
AN IMPRESSION OF THE MONORAIL CROSSING QUEEN CAROLINE STREET BY ST PAUL'S CHURCH HAMMERSMITH.

(Courtesy: Modern Transport.)





Courtesy: Barunger–Paris.

BOGIE LAYOUT

The design of the bogie, which includes both rubber suspension and rubber tyres, is described in the following extract from the same Journal.

" The bogie is fitted with four running wheels and four horizontal guiding wheels, all fitted with pneumatic tyres. It is driven by two electric motors taking current from a conductor inside the top of the box girder. The welded steel bogie frame is in H form. At the front and the back are extensions carrying the apparatus for controlling the guide wheels, which run loose. The spring suspension supports for the pantograph are carried on the bogie.

" The primary suspension consists of rubber units which isolate the bogie frame from the axles. It has the advantage of absorbing sudden longitudinal stresses, of providing an elastic reaction to the motor coupling and balancing the over-run of the motor. On the other hand the flexibility of this suspension combines with that of the bogie to lessen the effects of the instantaneous displacement of a wheel following an accidental variation in the profile of the track. There are eight flexible elements per axle and the flexibility for an axle is about .04 in. per ton.

" The secondary suspension has received special attention. In effect, running on pneumatic tyres brings an appreciable improvement in the comfort of the passengers by the avoidance of unsprung weight and by elimination both of noise and of high-frequency vibrations caused by steel rails.

The suspension of the car from the bogie has therefore been given variable flexibility; this is obtained by the action of an elastic thrust acting progressively in parallel with the central helical spring. The pivot is formed by a ring of rubber resting on the central spring by means of a slide. This is an adaptation of the bogie suspension arrangement frequent in French locomotive design; it requires no lubrication and damps out vibration. The rubbing surfaces in the pivot guide are composed of bands of Ferodo steeped in oil before mounting. This arrangement avoids noise and provides a check for the helical spring. To reduce lateral rolling a stabilizing bar is fitted on the top of the carriage. It is coupled to the bogie through Silentblocs.

" The running wheels are standard Michelin Metallic lorry wheels mounted on false hubs and arranged to be detachable. The diameter under load is about 3 ft. 2 in. to 3 ft. 4 in. The pneumatic tyres are capable of normally supporting the stresses due to the material loads as well as the tangential stresses resulting from acceleration and braking. The inner tubes will be filled with nitrogen to avoid the danger of fire in case of abnormal heating. A pressure connection to the driver's cab could, if necessary, be mounted on each wheel. In this case the deflation of a tyre could be indicated by a warning lamp.

" The lateral guide wheels would run in a horizontal position mounted on shœs fixed to the ends of the front and rear bogie frame stretchers. They would carry special nitrogen inflated pneumatic tyres of 2 ft. 4 in. diameter capable of withstanding the guiding stresses. The wheels would run in roller bearings; wedges allow the adjusting wheels in order to provide correct positioning for the guidance of the cars even after tyre wear has taken place. Precautions are taken in the design to prevent a wheel breaking away and fouling a bogie".

A typical car design seats 60 passengers with ample space for luggage and allows for a speed of 70 m.p.h. on a run from London Airport to the suggested terminal near Earl's court.

We are indebted to International Monorail Ltd., Hitchins, Jervis and partners and "Modern Transport" for assistance in the preparation of this article.

A CENSUS OF IRON & STEEL FACTORIES IN INDIA

According to a census of manufacturing industries, there were altogether 131 iron and steel smelting, rolling and re-rolling factories in India during 1954 which included three big producers of Iron and Steel viz; Tata Iron & Steel Co., Indian Iron & Steel Co., and the Government Steel Works in Mysore. Total productive capital employed in the industry was Rs. 70.19 crores comprising a fixed capital of Rs. 35.9 crores and a working capital of Rs. 34.29 crores.

The industry employed altogether 85,600 persons who received Rs. 18.13 crores as salaries, wages and other benefits.

During the year, the industry consumed fuels, electricity and lubrications worth Rs. 8.8 crores of which Rs. 6 crores was spent on coal. In addition, purchase of raw materials such as iron ore, spelter, iron and steel etc. increased the industry's expenses by Rs. 30.79 crores.

The value of goods produced by the industry in 1954 was placed at Rs. 8.072 crores of which finished steel products accounted for Rs. 64.38 crores; Blooms, Billets and Slabs for Rs. 6.81 crores; pig iron for Rs. 3.38 crores and others for Rs. 12.45 crores.

After allowing for depreciation and other charges, the value added by manufacture was estimated at Rs. 42.36 crores.

Manufacture of Telecommunications Equipment in India

By H. C. Towers, M.I.E.E., M.I.R.S.E., M.Inst.T.

INDIA has a steady demand for telecommunication equipment. These requirements are increasing with the rapid extension of telecommunication facilities throughout the subcontinent. With the experience of the second world war and the obtaining of independence in August 1947, self-sufficiency in the matter of telecommunication equipment was keenly felt. The largest government user is the Post and Telegraph Department and next are the railways.

The Government of India gave this problem very detailed consideration and finally on 3rd May 1948 an agreement was concluded with the Automatic Telephone and Electric Company of Liverpool and the Government of India. The basis of this agreement was that the A. T. E. Company should provide technical aid and assist India in the manufacture of telephone apparatus according to the schedule of equipment agreed upon. In return the Government of India would purchase telecommunication equipment from the A. T. E. Company through the Indian Telephone Industries, the name given to the new undertaking, until production in India was established. The agreement holds good for fifteen years.

In February 1950 the industry was made into a private joint stock company with three shareholders, the Government of India, the Government of Mysore and the Automatic Telephone and Electric Company. The authorised capital was Rs. 4 crores most of the shares being held by the Central Government. It is anticipated that the increasing activities of the industry will necessitate further increase in the capital.

The Indian Telephone Industries started assembling telephones from parts imported from the Automatic Telephone and Electric Company. This work was commenced in two hangers 175 feet by 75 feet situated on a site not far from Bangalore in South India. These accommodated the tool room, raw material accommodation, machinery awaiting assembly, etc. At the present time these hangers are only used as a store. There are now eight factory units each 220 feet by 120 feet. Two of these have been provided with lean to accommodation 80 feet by 40 feet each. Each unit is self-contained and has four service rooms 55 feet by 20 feet, two at each end. Two are used for washing and toilet and two for stores, switchboards, etc. The natural lighting in the factory is so good that even on dark, cloudy days no general artificial lighting is necessary. Exhaust fans provide adequate ventilation and overcrowding of workers has been avoided.

C. B. Manual Switchboard.

The offices are located in a three storied building in granite with a plinth area of about 13,300 square feet. Accommodation is provided for Administration, Accounts, Engineering, Purchasing and Sales Departments and there is generous room for extensions at both ends of the building. Houses are provided for a total of 1500 families. Amenities include schools, playing grounds, club, hospital, market and cinema. The factory ground covers an area of about 370 acres. Krishnarajapuram Railway Station is at the south east corner of the site and the works has siding facilities.


Relay adjustment.

In the first year of assembling telephones from imported parts, 15,000 telephones were completed. A production programme for manufacture in the initial stages was drawn up and tool making on a small scale was commenced. The staff consisted of 18 officers, 187 workers and 200 others. Five engineers were taken on loan from the Automatic Telephone and Electric Company.

By 1952—53 all the eight factory units had been completed and three canteens. The engineering of the exchanges, hitherto done by the A. T. E. was taken in hand. An order for thirty small channel carrier systems was received from the Post and Telegraph Department. The assembly of telephone exchange equipment was started. Plans were made for the manufacture of dials and condensers and the dial shop was laid out. There was a progressive increase in the sale of manufactured products and distinct from imported products. At the end of the year the staff consisted of 68 officers, 987 workers and 763 others. Psychological tests to ascertain the ability, talent and inclination of workers was further improved and a scheme was introduced for awarding prizes to employees making best suggestions for improvement to the factory and production. During the year 27,209 telephones were made and 8,000 lines of exchange equipment assembled. Recently, dials, uniselectors, uniselector banks and T 2000 selectro banks were new items of production taken up. Development work was carried out on (a) Fire alarm main control unit and sub-stations (b) railway control units (push button type) (c) railway control way station units and (d) magneto telephones. Manufacture of single channel telephone carrier systems was commenced and also a cheap type of 3 channel telephone carrier system was developed.

The factory is being gradually equipped with all classes of machinery. In June 1954 there were 1,050 machines in service. These vary in size from small, cord binding machines received as war reparations and most of these had to be entirely rebuilt. Bakelite moulding presses are installed and the capacity ranges from 27 to 150 tons pressure. All moulded parts for telephones and exchanges are being produced. 61 automatic lathes, capable of turning something like 30 million parts a year, are available. The smaller screws are made in machines capable of producing up to 130 a minute. The tropical climate is very severe on telephone equipment and every component has to be properly treated. The plating shop, which is remarkably free from fumes, provides chromium, cadmium, nickel, zinc and copy coatings. Heavy iron work is spray painted but first thoroughly cleansed from all rust and then bonderised. The rust is removed by spraying the material with steel shots under pressure.

A canteen run by the Employees' co-operative Society, supplies lunches, snacks, coffee and tea at reasonable rates. For those who bring their own food, suitable accommodation is provided for them to eat it in. A free supply of 8 ounces of milk per day is made to workers employed in certain operations such as plating, spray painting, polishing and moulding. A dispensary, with a full time medical officer, is available for first aid and out-patient treatment.

As already stated, the assembly work started early in 1949 and in 1950 the manufacture of parts commenced. The production rate was fixed at 25,000 telephones per annum to be increased as the demand arose. The present demand is somewhere in the region of 50,000 telephones per annum. The telephone consists of

265 items, without the dial, while the dial comprises 122 parts.

Other apparatus being manufactured are Central Battery, Automatic and Magneto exchanges, cable runways, protectors, arrestors and many other items essential for telecommunications. The progress in annual production can be seen from a few details given below :—

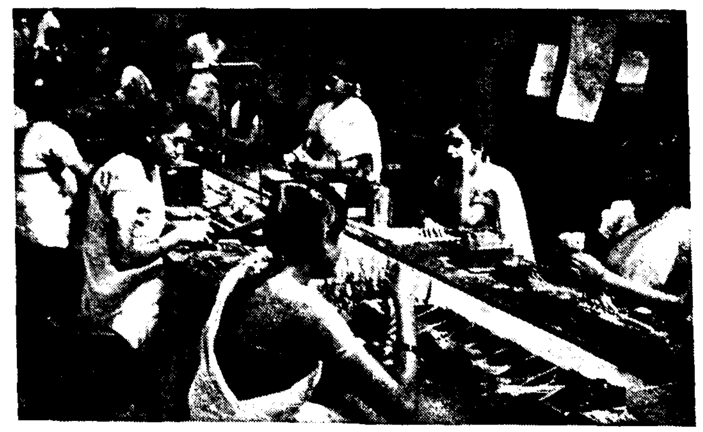
	1949–50	1951–52	1952–53
Telephones.	19,216	21,628	27,209
BPO 600 type relays.		11,300	23,277
BPO 2000 type relays.		2,900	46,387

The production programme for the coming years is far more ambitious than this and covers all classes of telecommunication apparatus including all types of railway traffic control equipment. Development is proceeding on transmission equipment. A single channel carrier system has been developed and is under field trial after prolonged laboratory tests. Voice frequency, ringing repeaters and transmission measuring sets are under laboratory tests. The first batch of ' Single channel Carrier Telephone system ' has just been completed for supply to the Indian Posts and Telegraph Department. This type of equipment has hitherto been imported and for the first time carrier telephone equipment has been made in India based on the design and development work carried out by the engineers of the Indian Telephone Industries. The equipment has been designed to utilise indigenous material as far as possible and to have a high degree of reliability under the severe climatic conditions obtaining in India. The first batch of equipment was demonstrated to members of the press and the I. T. I. on 15 May 1953. A device working in conjunction with a loudspeaker demonstrated (i) speech on the voice frequency circuit (ii) speech on the carrier circuit separately and (iii) the effective transmission on the line of the two different talks, one being intelligible and the other not due to carrier technique.

Carrier telephone systems are for use between trunk telephone centres for increasing the number of telephone circuits between them. With a trunk line joining two stations the normal arrangement permits of only one conversation. The ' Single channel carrier telephone system ', which comprises two terminal equipment, one of which is fitted at each end of the trunk line, increases the number of circuits from one to two thus making it possible to put through two calls at the same time. The maximum range of the system is 250 miles but by employing repeaters this range can be considerably increased. The additional speech circuit can only otherwise be obtained by the installation of a second trunk line. The cost of erecting a pole line of 100 miles with two copper wires would be over one lakh while the cost of ' Single Channel Carrier Equipment ' giving the same facility would be about one sixth of this. The circuit provided by the carrier system is of better quality, less susceptible to weather disturbances and more flexible for operating requirements.

Carrier technique enables the simultaneous transmission of the message originated by two or more subscribers independently of each other at the same time. Taking the case of the ' Single Channel Carrier Telephone System ', which permits two conversations at the same time, one of the conversations passes over the line in the usual manner while the signals corresponding to the second conversation passes through the carrier equipment to be modulated with a high frequency called ' carrier '. This modulated signal corresponds to the original signal with the only differences that the frequency is shifted into a higher range and passes over the line without interfering with the original conversation. The terminal arrangements at the other end is a selective circuit called a ' Filter ' and restores the conversation to the original form by demodulation.

The I. T. I. have been keenly alive to the importance of Research and Development in long distance line communication equipment. By June 1950 a development section for line transmission equipment was established. The ' Single Channel Carrier ' was taken



Assembling telephones.

up for development and quick progress was made. By January 1951 a working model was ready and this was exhibited in the Communication Engineering Laboratory of the Indian Institute of Science when opened by the Prime Minister of India. A complete system was ready by March 1952 and placed on field trial between Guntakal and Secunderabad. This system is still in service and working well. The Indian Posts and Telegraphs placed an order for 30 systems of this type. Other development work includes Voice frequency repeater, Secrephone and Transmission measuring set and prototypes are ready for field trial. Development of a three channel Carrier Telephone system is in an advanced stage.

To meet future demands for carrier and allied equipment in India, plans have been finalised for the early manufacture of such equipment on a large scale. Necessary buildings, machinery etc. have been arranged so that the bulk requirement of such equipment will be manufactured by I. T. I. The demand for new telephones is generally insatiable and it is recognised that in spite of the enormous expansion of the Indian Telephone Industries since its inception, the workshops will still have to undergo considerable development to meet the demands of the coming years. The objective is to make the country self-sufficient in telephones and long distance equipment in the shortest possible time.

INDO-SWEDISH TRADE AGREEMENT

According to an official announcement, the schedules attached to the Indo-Swedish trade agreement have been slightly modified for the current year. It may be mentioned that the agreement provides for revision of schedules every year. Important items included in the list, amongst others, for exports from India are: Manganese ore, magnesite, kyanite, chrome and iron ores, and for imports into India are: iron and steel including ferro alloys and stainless steel, metal manufactures and semi-manufactures, various machinery and industrial equipment e.g., diesel engines, metal and woodworking machinery, ball and roller bearings, electrical equipment e.g. generators, transformers, railway rolling stock and locomotives etc.

Principle of Cartridge Operated Tool Fixings

By H. G. Chase

FOREWORD

THE purpose of this paper is to survey the principle of cartridge operated tools and the applications on contracts in the simplest possible way. Attempt to prove the intrinsic value of a forced entry fixing by means of a cartridge, and to indicate the physical change that takes place in the material and the shaft of the steel fixing.

ORIGIN

Contrary to general belief that the principle of cartridge operated tools originated on the Continent, the first patent application was in fact lodged by Mr. Cox of Temple Cox Development Co. Ltd., Kent in 1910, from which the Temple Cox Underwater Gun was developed and adopted for use by the Royal Navy for temporary underwater repairs to ships damaged in collision or as a result of enemy action.

The method, involved firing a specially hardened steel bolt, designed in such a way that in conjunction with a cartridge of controlled power, it would penetrate to a pre-determined depth in steel when the thickness and tensile strength were known.

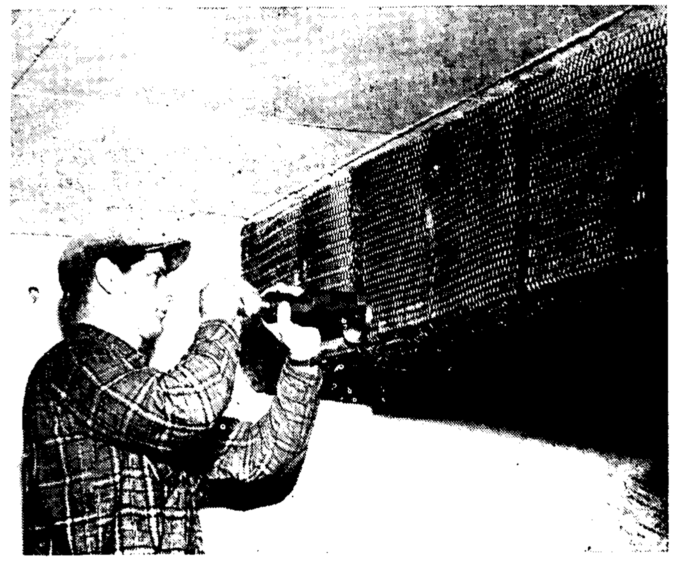
DEVELOPMENT IN BUILDING INDUSTRY

The vast potential for a tool of this nature in the Building Industry was recognised and developed after the last war by Companies in America and on the Continent and in 1951 this Company opened the existing factory at Dukinfield, Cheshire, and commenced production of the Rapid Hammer.

D. S. I. R. carried out trials at the Building Research Station, London, testing a number of tools including the Rapid Hammer and subsequently published a report on their findings in the trade press, and in particular "The Builder" 1952 September edition.

PRINCIPLE OF CARTRIDGE OPERATED FIXINGS

The factors involved in the firing of a specially hardened steel nail into steel, concrete or other materials, differ to the orthodox or traditional method of fixing in one positive way, the material is displaced



Cartridge operated Tool Fixing.

as opposed to being removed. The principle governing the initial retention of the fixing in a given material is the amount of compression imposed between the shaft of the fixing and the surrounding material.

In traditional fixings the area is restricted to the wall of the hole made by pre-drilling, whereas in cartridge operated fixings the result is much more interesting and complex.

(a) There are two specific combinations, the length diameter and tensile hardness of the nail on the one hand and the propulsive power of the cartridge on the other.

(b) The material into which the fixing is being fired (for purposes of abbreviation the fixing will now be known as F. E. ("forced entry"). This material can be sub-divided into three main groups steel, concrete and brick and each group classified in density and flexibility.

This classification in density and flexibility is not concerned with the movement of the mass as a whole, but rather movement within the mass and can be translated in steel as non-ductability and ductability and in concrete and brick as non-porous and porous.

For example, a cheap building brick of high porosity will allow greater movement within the mass before causing disruption of the whole than would a first class engineering brick with a low porosity.

The prime feature associated with this movement in concrete and brick is the consequent increase of retentive forces around the shaft of the fixing, with increase of density, up to certain limits.

It will be seen from Fig. 1. the direction of the displacement of material resulting in compression that takes place when a F. E. fixing is made.

In order to give some indication of the degree of compression of material around the shaft of bolt, one must scale the porosity or density of the material so that we can have some indication of the degree of success to be obtained with this method of fixing.

A rough guide in brick is porosity from 100% down to 5% using the 24 hour water/weight test and concrete up to 6,000 lbs. compressive strength by cube test using maximum $\frac{3}{4}''$ down aggregate, we can draw the correct conclusion from this with the lower porosity in a brick and the higher compressive strength in concrete to obtain the maximum compressive force around the shaft of bolt.

F. E. FIXINGS IN CONCRETE

An interesting feature of this compressed material is that you have in effect a core literally welded to the end section of the shaft. In concrete this is due to two distinct features, during its entry into the material, the steel is subject to abrasion on the surface and the forced entry of the shaft into the concrete breaks up a proportion of the globules of water and cement not distributed during the mixing process resulting in further hydration of cement within the highly compressed area. The fixing is now impervious to drying out of the material due to atmospheric conditions and is of paramount importance when the fixing is in tension or tension/shear. (See fig. 2.)

F. E. FIXINGS IN BRICK

In brick the effect is similar but there is no advantage of further hydration of cement within the compressed material, but this is compensated by being a more consistent homogeneous material.

F. E FIXINGS IN STEEL

The retention in mild steel is simplified by two factors (a) the material itself is ductile and (b) it is homogeneous and consistent in tensile strength within reasonable limits, for example, when a nail with a $\frac{1}{4}''$ shaft is fired into steel considerable frictional heat is

FIG. 1.

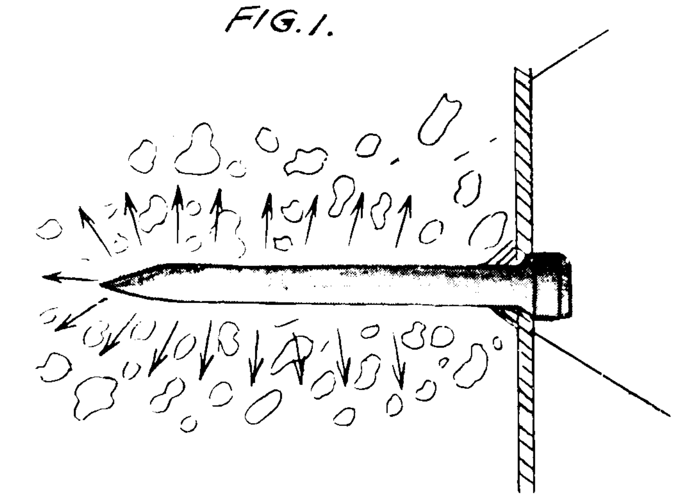
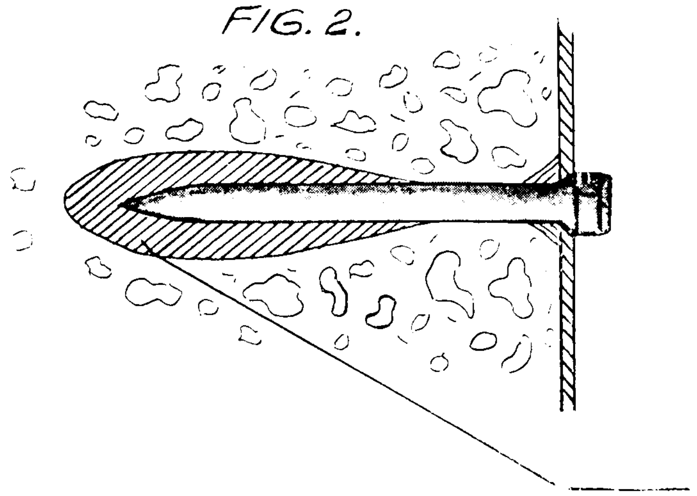


FIG. 2.



developed in the material contacting the shaft surface. This heat is rapidly dissipated causing contraction of the material around the shaft. This process is accentuated by the higher degree of expansion/contraction movement in the mild steel than in the high tensile steel and results in a positive bond between the two materials.

This contraction can be used to increase the bond by adding a key to shaft either by knurling or other method of indentation into which the material will 'flow'. Maximum retention is obtained when the thickness of steel is three times greater than the diameter of shaft and the minimum limit is when both are equal.

The chart given in fig. 3 gives an indication of values in tension in a variety of materials.

SAFETY FEATURES INCORPORATED IN THE BASIC DESIGN

Certain basic safety features must be incorporated in cartridge operated tools to prevent their classification as Firearms. Foremost among these are :—

(a) That they cannot be fired freely and

(b) The barrel or other basic operating feature must require a minimum pressure of 20 lbs. to telescope it fully into the body of tool before the firing mechanism can operate.

In designing our own tool the safety features were in the following order :—

(a) It can not be fired freely.

(b) It can not be fired if held at an angle to the material.

(c) Minimum pressure of 20 lbs. to depress the barrel into casing.

(d) Barrel to be fully depressed with operating angle tolerance of 5 degrees to cope with uneven surfaces. (Governed by permanent steel 4" diameter protection skirt, attached to body of tool) before firing mechanism can operate.

(e) Gas escape ports in barrel allowing residual gases to dissipate inside chamber of casing to decrease noise and add to comfort of operator especially in confined spaces.

(f) The high tensile steel fixings are themselves ductile which allows a bending movement of up to 90 degrees, thus preventing hazard to operator and those in the vicinity due to ricochet as a result of bolt shearing.

These features were dealt with in more detail in my paper to the London Building and Engineering Contractors Safety Group in June 1956 and published in the 1956 October issue of this Journal.

BRIEF SELECTION OF APPLICATIONS ON RECENT CONTRACTS

Steel. Recladding of Condensation Tanks.

The recladding of condensation tanks with $\frac{1}{8}''$ mild steel plates to 5/16" $2\frac{1}{2}'' \times 2\frac{1}{2}''$ angle iron frame on the I. C. I. Dyestuffs Division Factory, Grangemouth, Scotland. Contractors Messrs. Frederick Braby & Co., Ltd., Outside Contract Department, Glasgow, Scotland. The prime feature here was saving in time, plus drastic overall reduction in fixing costs. Some 30,000 bolts were used employing the direct fixing method of firing the bolt through the steel sheet and 5/16" angle iron in one operation without any pre-drilling. Reports have since confirmed that the plant is now operating with greater efficiency than by previous traditional method of fixing.

Fixings into Solid Steel.

At the Calder Hall Atomic Power Station, Sellafield, Cumberland, some 100,000 fixings were used inside the re-actors to fix strip metal to *solid steel*. The time/labour reduction on this application can be appreciated when compared with drilling and tapping 100,000 holes which would otherwise have been necessary.

Concrete.

New Church—Mount Merrion, Dublin, Eire.

Contractors John Du Mowlem & Co., Ltd.

Some 10,000 3" nail fixings were used on this one contract (others of similar nature have since been carried out) to fix a $1\frac{1}{4}'' \times 2\frac{1}{2}''$ timber battens to reinforced concrete walls to which was affixed fibrous plaster panels to form inside decorative surface and provide insulation against heat loss.

The fixing was fired direct through timber, lining up spacer and $1\frac{1}{2}''$ into reinforced concrete in one operation. The clear overall saving was in excess of 6d. per fix compared with traditional methods.

New Office Block, Baker Street, London.

Main Contractors—Sir Robert McAlpine & Co., Ltd.

Metal Window Frames Supplied and Fixed by Williams & Williams Ltd.

Using our $1\frac{1}{2}''$ Nail Type Fixing.

Firing direct through $\frac{1}{8}'' \times 1''$ Metal fixing cleat into concrete surround. Over 25,000 fixings have so far been used on this contract.

Overall saving in fixing costs.

Brick/Concrete.

Perhaps the best illustration on the above application was the lining out of the testing shop at Daimler Works, Coventry. The brick was engineering and the roof concrete.

Some 10,000 feet of 'grounds' were fixed using $2\frac{1}{2}''$ nail type fixings in both the concrete roof and brick walls. The same strength of cartridge was used throughout the construction. Insulation material was fixed to battens to reduce noise and engine testing 'chatter' vibration to main structure.

GENERAL APPLICATIONS

B. Type Fixings

Some 50,000 B. type bolts externally threaded in conjunction with ¼" tapped Pipe Clips have been used by Messrs. J. R. Williams of Manchester for the purpose of fixing conduit.

S. & P. Type Fixings

Internally threaded bolts tapped 4BA, 2BA and ¼" which can be fired into materials so as to be flush with surface or proud as required into which bolts of similar thread can be screwed. These are used mainly by Electrical Contractors.

This short list of recent and current applications on contracts has been chosen for two reasons :—

1. They indicate the considerable saving in man hours and overall fixing costs.
2. The number of fixings used will point to their reliability on contract.

There are two models, ¼" R. 7. as exported to the United States of America and the ¼" and ⅜" Universal Model the R. 12. with interchangeable barrels. Extension barrels and special shields can be supplied with both.

SUMMARY

Whilst cartridge operated fixings are superior on many applications to traditional methods and do in fact show a very considerable reduction in man hours and overall fixing costs, one must not assume they are a panacea for all fixing problems.

In company with any tool designed to carry out a specific function there are limitations in scope.

This brief outline on the physical conditions associated with cartridge operated fixings will, I hope, bring into focus the positive features within the limits of application.

Fig. 3.

TABLE I.

Results of Tests carried out with ¼" Shaft Bolts.

Nature of Fixing.	*Result.*	*Force required for extraction.*
Into concrete 1 : 2 : 4 mix ⅜" aggregate	Penetration 2⅜ in. Stud firm. Slight flaking of concrete around point of penetration.	Not tested.
Ditto	Penetration 2⅝ in. Slight flacking around point of penetration.	6,000 lb.
Into concrete 1 : 2 : 4 mix ⅜" aggregate	Penetration 1.11/16 in. Stud driven firmly up to shoulder of thread. Slight chipping of concrete around point of entry.	2,400 lb.
A standard malleable iron electric junction box to 4½ in. brick wall.	The box, which had not been previously drilled to take the pin, was firmly fixed.	Not tested.
Into 9 in. brickwork Fletton bricks.	Bricks chipped at surface but not split.	2,400 lb.
2 in. by 1 in. deal batten to concrete wall 12 ins. thick. Mix 1 : 6 1½ in. "all in" aggregate.	The head of the pin was flush with the surface of the wood.	Not tested.
2 in. by 1 in. deal batten to concrete slab. Mix 1 : 2 : 4 ⅜ in. aggregate.	Head of pin remained standing ¼ in. above surface of batten.	1,700 lb.
¼ in. thick mild steel to 6 in. by 6 in. timber beam.	The pin was driven through the plate into the timber. The fixing was satisfactory.	Not tested.

TABLE I - (Contd.)

Nature of Fixing.	*Result.*	*Force required for extraction.*
Standard malleable iron electric junction box to web of 6 in. by 3 in. R.S. joist.	The box was firmly and satisfactorily fixed.	Not tested.
Pin driven into ⅜ in. thick M.S. plate.	Depth of penetration 9/16 in.	2,100 lb.

TABLE II

Results of Tests carried out with 5/32" Shaft Bolts.

Nature of Fixing.	*Result.*	*Force required for extraction.*
Into concrete 1 : 2 : 3 mix ⅜" aggregate	The pin penetrated 1¾" concrete slightly shipped.	4,000 lb.
Into concrete 1 : 2 : 4 mix ¾" aggregate Cube strength 5,800 lb. per sq. in.	The pin penetrated 1⅛".	2,700 lb.
Standard malleable iron electric junction box 12 in. thick concrete wall. 1 : 6 mix 1½ in. aggregate	The box was firmly held to the wall, the head of pin protruding 3/16" into box.	Not tested.
Into brickwork Common brick	2⅛ in. penetration 1½ in. penetration 1⅛ in. penetration	4,500 lb. 3,400 lb. 2,700 lb.
2 in. by 1 in. deal batten to concrete. Cube strength 4,800 lb. per sq. in. Aggregate ¾ in. granite chips	The head of the pin was ⅜ in. below the surface of the wood. A secure fixing was made.	Not tested.
2 in. by 1 in. deal batten to concrete. Cube strength 5,400 lb. per sq. in. Aggregate ¾ in. limestone chips.	The head of the pin came to rest just below the surface of the wood. A secure fixing was made.	Not tested.
2 in. by 1 in. deal batten to 4½ in. brick walls. Fletton brick. See Fig. 2.	The head of the pin stopped just below the surface of the wood. A secure fixing was made.	Not tested.
Standard malleable iron electric junction box to 4½ in. brick wall. Fletton brick.	The junction box was firmly and effectively fixed to the wall.	Not tested.
Two M. S. plates each ¼ in. thick joined together	Two pins were driven into the plates. The heads were partly buried in the top plate.	A shearing force of 2,600 lb. was required to separate the plates. The pins pulled out of the bottom plate.

"BLACK LIGHT" Spots Oil Leaks

"BLACK LIGHT" inspection is proving to be the answer to another troublesome diesel maintenance problem on the Southern Railway System.

For almost a year now the Southern has been using standard Magnaflux ZB26 portable black light units to find small leaks in diesel engine fuel lines in a fraction of the time formerly required, and with much more reliability.

Fuel oil leaks are an important cause of lubricating oil dilution. They are very difficult to locate by ordinary visual inspection, using a wiping rag and a flashlight, because the areas where leaks most often occur are usually covered with a film of lube oil, which blends with the thinner fuel oil.

That the ZB26 lamp could be used to locate fuel oil leaks was discovered last year by a technician in the Southern's Test Department, C. L. Crymes, who is Supervisor of Diesel Water Treatment. The ZB 26 had already been used extensively in the Magnaglo process for locating cracks in crankshafts, rods and other locomotive parts. It is a high-voltage mercury-arc lamp with a filter designed to eliminate all rays except those in the near ultra-violet region.

Under the violet light produced by the ZB26 lamp, Crymes noted that lubricating oil takes on a characteristic light gray or chalky white fluorescence; while fuel oil shows up as a light, milky-blue colour. Thus, by illuminating an area where leaks are suspected with the black light any fuel oil present can be instantly detected, even when mixed with lube oil.

The testing procedure developed by the Southern is a simple one. First, pressure is built up in the fuel lines, either by idling the engine or (in the case of engines having an independently-operated fuel pump) by turning on the fuel pump. Then, with the engine room darkened, the lamp is used to probe the areas where leaks usually occur, paying particular attention to connections between the fuel lines and injectors and between fuel lines and manifold. Any leak—even a small one—is readily found by tracing the characteristic light blue fluorescence of the fuel oil to its source.

TINY fuel leaks are often camouflaged when the seeping fuel mixes with surrounding lube oil. ....But fuel oil can be made to betray its presence by flashing the violet beam of a black light unit on the surface being examined. The new inspection aid has proven itself so reliable that Southern has now adopted it as a regular maintenance procedure.

After the leak has been repaired, lube oil is smeared over the area and another black light inspection made. A slow-spreading blue stain against the gray of the lube oil indicates that fuel oil is still seeping out and that further attention is required.

This black light inspection has proved so reliable and time-saving that the Southern has made it a regular part of its diesel maintenance procedures. Regular black light tests are made during monthly inspections of locomotives at the System's diesel shops.

In addition, fuel lines and connections are inspected with black light any time the Test Department reports fuel oil dilution in one of the lube oil samples that it analyses periodically. In this way, leaks can usually be located before the lube oil has been diluted to the viscosity condemning limits. Previously consistent dilution sometimes occurred; yet the source could not be located by ordinary visual inspection.

Although fuel oil leaks are not alarmingly frequent they can be costly if not caught in time. With black light the Southern is catching them earlier, besides eliminating much time-consuming and uncertain "manual" inspection. In fact, one Southern diesel specialist has called the new technique "the greatest discovery in the diesel engine maintenance field in the last 10 years".

Already other railroads have begun using black light for this purpose.

Courtesy: "Modern Railroads"

DO YOU KNOW?

1. During the First Plan period 430 miles of railway lines dismantled during the war were restored, 380 miles of new lines constructed and 46 miles of narrow gauge line converted into metre gauge.

2. By the end of the Plan, ten new lines totalling 453 miles were under construction, 52 miles of lines were under conversion into broad gauge and surveys for 2,000 miles of new lines were in progress.

3. Of the nineteen new lines totalling 758.92 miles opened to traffic since independence, twelve were executed during the First Plan period.

4. The most important of these new lines was the Assam Rail Link measuring 142 miles. In spite of adverse conditions, the project was completed well ahead of schedule.

5. Work on the Mukerian—Pathankot line was started in November 1949 and the line was formally opened for traffic on April 7, 1952. This 27 mile-long line has cut short the distance between Delhi and Pathankot by 44 miles.

6. The Kandla (Gandhidham)—Deesa Rail Link of 170 miles opened to traffic on October 2, 1952. Kandla on the west coast has thus been linked with the hinterland.

7. The main features of the programme of development under the Second Plan are: doubling of 1607 miles of track; conversion of 265 miles of metre gauge lines into broad gauge; electrification of certain sections totalling 825 miles; dieselisation of 1,293 miles; construction of 842 miles of new lines, and renewal of 8,000 miles of obsolete track.

A New Range of Mechanical Lubricators

A new range of mechanical lubricating equipment is now being manufactured in Great Britain. This is the result of an agreement between Davies & Metcalfe Ltd., Romiley, Stockport, and Alex. Friedmann, Vienna. The latter company have manufactured high class mechanical lubricators and accessories for very many years and are well known in most parts of the world.

The firm of Davies & Metcalfe Ltd., are very old established Locomotive Engineers who have manufactured Exhaust Steam Injectors, Vacuum Brake Ejectors, and Live Steam Injectors, etc. for almost every railway company in the world. They therefore have all the engineering knowledge, both practical and theoretical, and all the design experience, to ensure that they can manufacture precision mechanical lubricators with that high degree of accuracy and finish that is so necessary.

A feature of this equipment is the very excellent design and general high class of workmanship throughout, and it will be noted that the pump units operate on a system which obviates the use of ball valves for the inlet and outlet ports, a point of utmost importance for reliable lubrication.

At present, this Company is concentrating on lubricating equipment for steam, diesel and electric locomotives, but it is their intention to widen their field almost immediately to include industrial and marine lubricating requirements generally.

In connection with locomotive lubrication, they manufacture the Metcalfe Automatic Steam Brake Cylinder Lubricator, the Friedmann type F. S. A. Valveless Mechanical Lubricator and D. V Pattern Lubricator, which is a standard lubricator for many of the world's largest railways, also Wheel Flange Lubricators, in addition to a wide range of fittings and appliances for use in conjunction with mechanical lubricators such as low and high pressure terminal check valves, oil dividers, atomisers, unions, etc.

An entirely separate lubricator department has been constructed at the Romiley works and this will ensure that all lubricating equipment is assembled and tested under ideal conditions. When we recently visited these works, we were pleased to note that special steps had been taken to ensure perfect cleanliness throughout this new department.

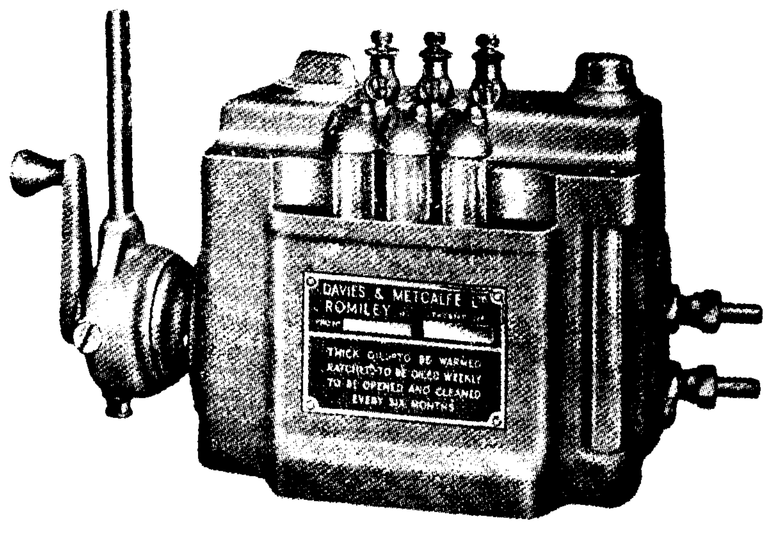


Fig. 1

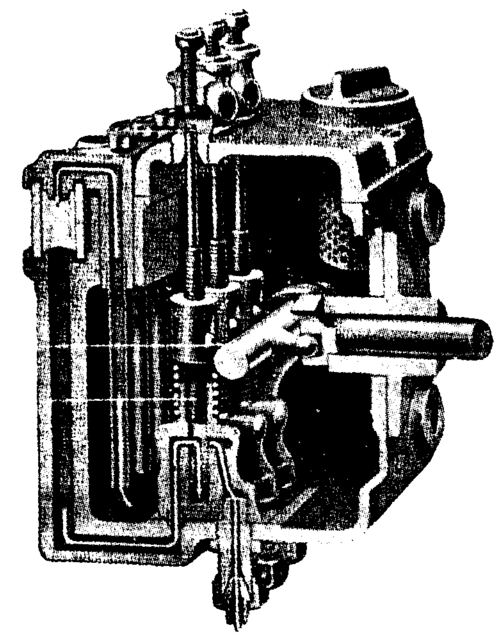


Fig. 2

Figs. 1 and 2. The Type D.S.I. Lubricator is very soundly designed and constructed and may be used for most industrial purposes.

THE TYPE D. S. I. MECHANICAL LUBRICATOR

This style of lubricator is suitable for general industrial and marine applications, and it is capable of using all normal grades of lubricating oil. Figure 1 shows the lubricator which, it will be noted, is equipped with sight glasses to each feed.

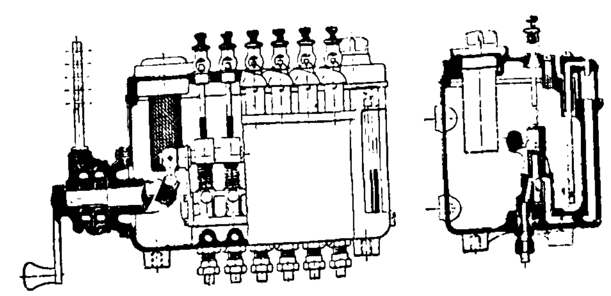


Fig. 3. Sectional drawing of the D.S.I. Lubricator.

The working of the lubricator may be seen from Figures 2 and 3, and the method of pump operation is by a shaft common to all pumps which lifts and simultaneously turns the plungers. This movement automatically opens and closes the suction and delivery ports of the pump units so that no ball valves are required in the operation of the lubricator which is thus free from the failures and troubles associated with lubricators employing ball valves. An additional advantage of this system is that it is safe to arrange the sight feed to be on the suction side of the pump without fear of the oil thus sighted not reaching the lubricating point.

The advantage of sight feeds of this type is that there is no need to pass the oil through water or glycerine, and thus the likelihood of broken sight glasses, freezing of water, displacement of water by oil, etc., are all eliminated. The makers claim that since there are no valves to interfere with the flow, all oil reaching the delivery side of the pump, must pass to the outlet side.

Rate of delivery for each plunger can be regulated by adjusting its stroke. Regulating screws are fitted to the top of the oil container and range of delivery is from 0 to 0.33 c. c. per stroke. As the tail end of each plunger rises, it passes through the top of the container to meet the regulator screw, thus visible observance of its motion is possible.

Should any oil accumulate in a sight feed glass, it is only necessary to loosen the top screw just above it, when surplus oil will at once disappear. A gauze filter is fitted under the filler cap, and a steam heating pipe, for use with very thick oils, or the ensure constant temperature of the oil at all times, can be fitted if required. Steam pipe connections can be seen in the unit illustrated. Fixing lugs or studs can be incorporated to suit the customer's requirements.

THE RATCHET DRIVE

The method of driving the lubricator may be by ratchet from reciprocating motion, or by chain or reduction worm gearing (standard ratio 38.1) from rotary motion and the drive may be arranged on the right or left underside of the body in addition to the front position which is shown in Figure 2. The type of ratchet drive employed attracted our attention, particularly when we were viewing the arrangements being made to produce these lubricators. One of the most frequent sources of trouble on ratchet driven lubricators is the ratchet itself, and is usually due to a faulty pawl, or to wearing of the ratchet wheel teeth. The fitting of a trouble-free ratchet is a valuable asset to any mechanical lubricator.

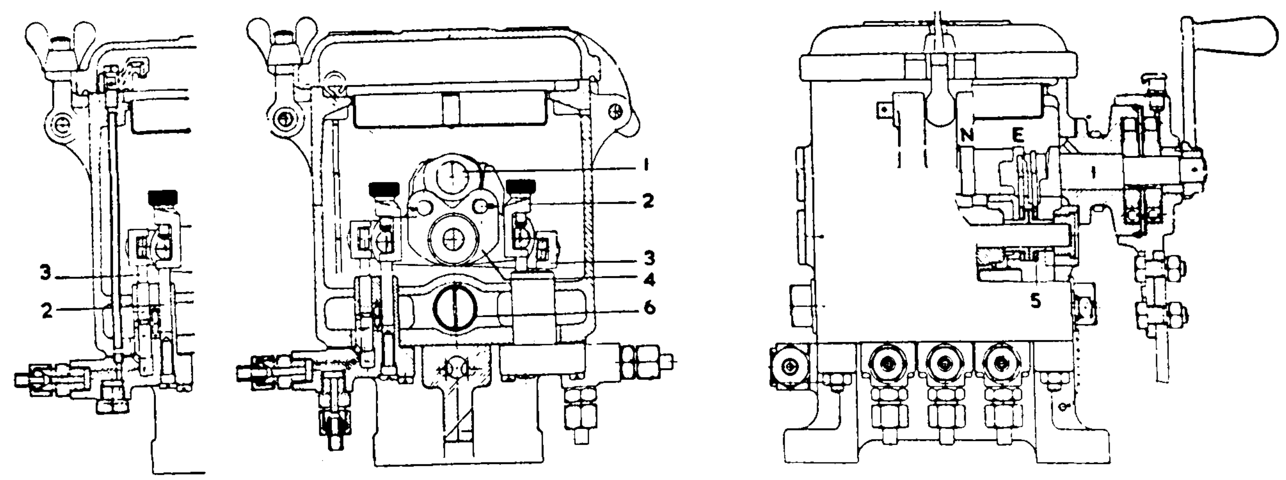


Fig. 4. Sectional drawing of the Type F.S.A. Lubricator. LH drawing shows method of converting pumping units to single feeds instead of double ones.

The arrangement of this ratchet assembly can be followed from the sectional drawing of one included in Fig. 4. The drive consists of two discs each having five rollers which are spring loaded. One set of rollers and disc is for driving and the other set is to prevent backlash. The advantage of this system is that complete absence of backlash is maintained over prolonged service, a positive drive is ensured under all conditions no matter how short the stroke of the operating lever, there is freedom from wear, and operation is silent.

RANGE AVAILABLE

A full range of these lubricators to meet most industrial purposes is, or very shortly will be, available. There are to be seven sizes of container to hold from one to twenty-one pints of oil, and they may be divided into two or more compartments, if required, to separate differing grades of lubricant, e. g., cylinder and bearing oils. Any number of feeds from one to nineteen may be incorporated. Non-return valves, for fitting near to the points of lubrication, are provided when these lubricators have to feed against steam or air pressures.

THE TYPE 'D' MECHANICAL LUBRICATOR

This lubricator is identical in construction and operation with the type D. S. I. with the exception that it is not fitted with sight feed glasses, and is consequently somewhat simpler and cheaper.

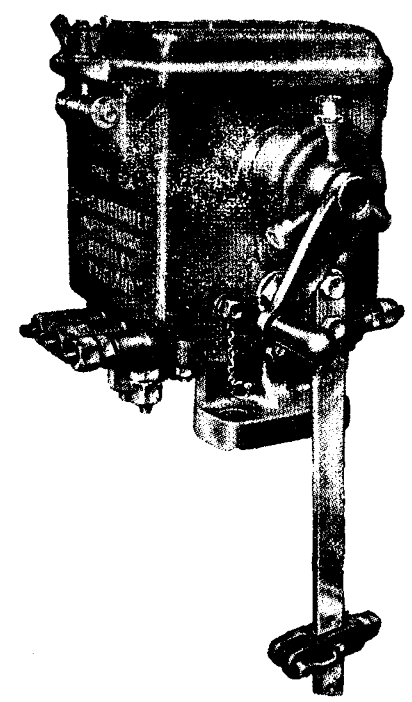


Fig. 5. The type F. S. A. Lubricator, designed primarily for locomotive work.

THE TYPE F. S. A. LUBRICATOR

This lubricator is designed for heavier duty, primarily for use with steam locomotives, and is illustrated in Figs. 4 and 5. This again, is a valveless lubricator and each pumping unit has a delivery and distributing piston. The pumping units are an exceptionally high class precision made job, the pistons being perfectly oil-tight up to a pressure of 3,000 lb./sq. in. and the delivery to oil is most accurate and reliable under any conditions of working. They are valuable lubricators for use on all types of steam engines.

Referring to Fig. 4. the driving shaft, 1, is supported in the body of the lubricator and has five cams formed on it, as illustrated. The cam marked "N" is a double one and operates the delivery pistons, 2, whilst the two sets of eccentric cams, item E, operate the distributing pistons, 3. The delivery pistons are operated through the delivery piston rocker, 4, and the distributing pistons by means of the distributing piston rockers, 5.

The arrangement of double and eccentric cams for delivery and distributing pistons is a feature of the design of this lubricator and enables each delivery piston to make two strokes per revolution of the driving shaft whilst at the same time, the distributing piston makes one single stroke. Thus, each pumping unit may be termed double acting and for a revolution of the driving shaft, oil may be delivered separately and independently from the two outlets provided on each pumping unit. There may, incidentally, be one or two outlets as required.

Regulation of total delivery is made by altering the travel of the operating lever, and also by varying the outlet of individual pumps by adjustment of the piston stroke. Since one regulating screw alters the output of two outlets, two similar points, e. g., pistons, valve guides, axle boxes, etc., may advantageously be connected to the two outlets of one pumping unit, thus ensuring identical quantities of oil being delivered to two similar points.

A filling strainer is provided but a further strainer, 6, ensures that only clean oil can reach the pumping units. This is an additional safeguard against some uninitiated person filling up the lubricator with the filler-strainer removed.

The F.S.A. lubricator is made in two sizes. The small one has up to twelve outlets and the larger one up to 24. The number of outlets in each case may be varied by converting the pumping units to single feeds and substituting the internal drip pipe, as shown in Fig. 4.

A full range of accessories are available, as with all Davies & Metcalfe lubricators, including check valves, atomizers, unions, etc. Sight feed indicators for fitting in the delivery lines are also available. When the lubricator is employed for steam locomotive work, terminal check valves may be employed for feeding against steam pressure and as these incorporate feed test cocks, sight feed indicators may not be needed.

THE METCALFE OIL DIVIDER

Where it is desired to increase the number of points fed from a lubricator and where additional feeds are not available on the lubricator itself, the Metcalfe Oil Divider provides a solution. This is made with two or four outlets and the value of this piece of equipment is not so widely known as it should be, since its uses are very numerous throughout lubrication systems.

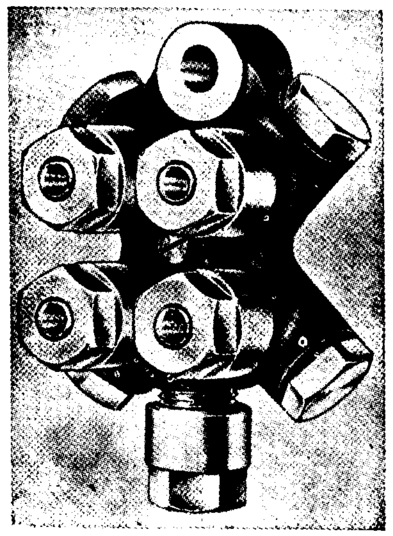


Fig. 6. The Oil Divider allows a lubricator pump to feed several points without the disadvantages of "split" feeds.

It is well known to Lubrication Engineers, that it is dangerous to employ split feeds for lubrication of important points because the oil always takes the line of least resistance and whenever one line gets partially choked, all the lubricant goes the one way. The Oil Divider allows a small sized lubricator to feed to a greater number of points than there are pumping units, without fear of starvation of any point. When connected in tandem, the Oil Dividers will still further increase the number of points that can be fed, providing it is borne in mind that the last points in such a circuit will only receive their "divided" supply. The Oil Divider is illustrated in Fig. 6, and Fig. 8 shows how it may be connected into a lubrication system. Fig. 7 is a sectional illustration.

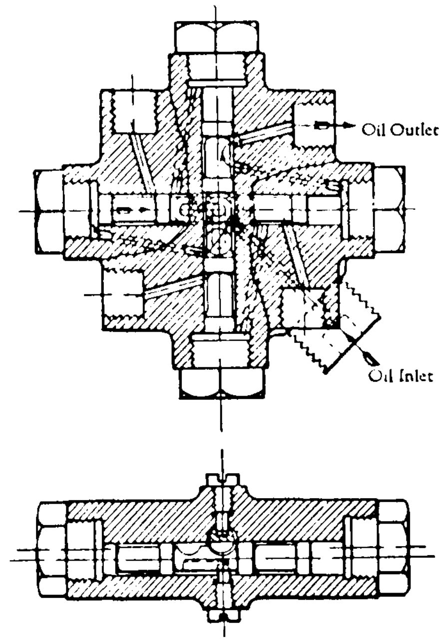


Fig. 7. Sectional drawings of the Metcalfe Oil Divider.

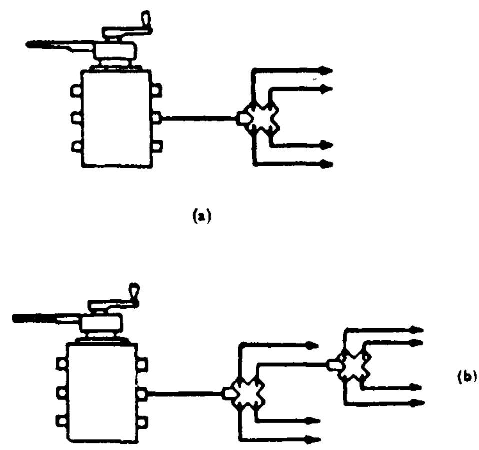


Fig. 8. Illustrating methods of connecting (a) one Oil Divider to feed to four points, (b) two or more Dividers to feed to seven or more points.

Oil is supplied to the Divider from a feed of the mechanical lubricator. The Divider has two pairs of oil-tight pistons which slide in cylinders formed in the body of the Divider. Each piston and cylinder has inlet and outlet ports, and the construction is such that the inlet port of only one piston is open at a time. In

operation, the pistons move in a cycle and oil is delivered from each outlet union in turn, under the same pressure as the delivery from the lubricator.

The advantages of the Divider may be summarized as follows :—

(1) A great number of points may be lubricated from comparatively few pumping units.

(2) Each point is fed with a positive supply of oil as soon as the lubricator commences to work, and supply is proportional to the speed of driving the lubricator.

(3) Regulation to a fine setting at the lubricator pump, ensures economical lubrication.

(4) Positive supply of oil to each point is irrespective of the difference in resistance to flow of each of these points.

(5) The use of Oil Dividers may save the cost of an expensive lubricator employing additional individual pumping units. In addition, a considerable saving in space and cost is effected since multi-feed lubricators can be large, unwieldy and costly.

CAN BE USED WITH SOFT GREASE

The Oil Divider is generally used in conjunction with a mechanical lubricator and requires a minimum of 75 lb./sq. in. pressure to operate it. It will work with all grades of oil and also with soft greases. Whilst primarily intended for use on low pressure lubricating points, using the Metcalfe standard low pressure terminal check valve, it is quite suitable for normal lubrication.

Adjustment of the delivery capacity of the pump feeding the Divider automatically increases or reduces the number of operating cycles of the pistons inside. Thus, whilst the amount of lubricant discharged per cycle is constant, the frequency of discharge is adjustable. The standard Divider discharges 0.028 cu. in. of lubricant from each piston per cycle. All Dividers are tested before delivery against a pressure of 500 lb./sq. in.

The Divider requires no maintenance beyond occasional dismantling and washing out with paraffin. Service life is claimed to be exceptionally long in view of the high grade materials employed and which always run in oil. Replacement pistons are not therefore supplied, and when wear does eventually take place, a new unit should be installed.

INDEX TO ADVERTISERS

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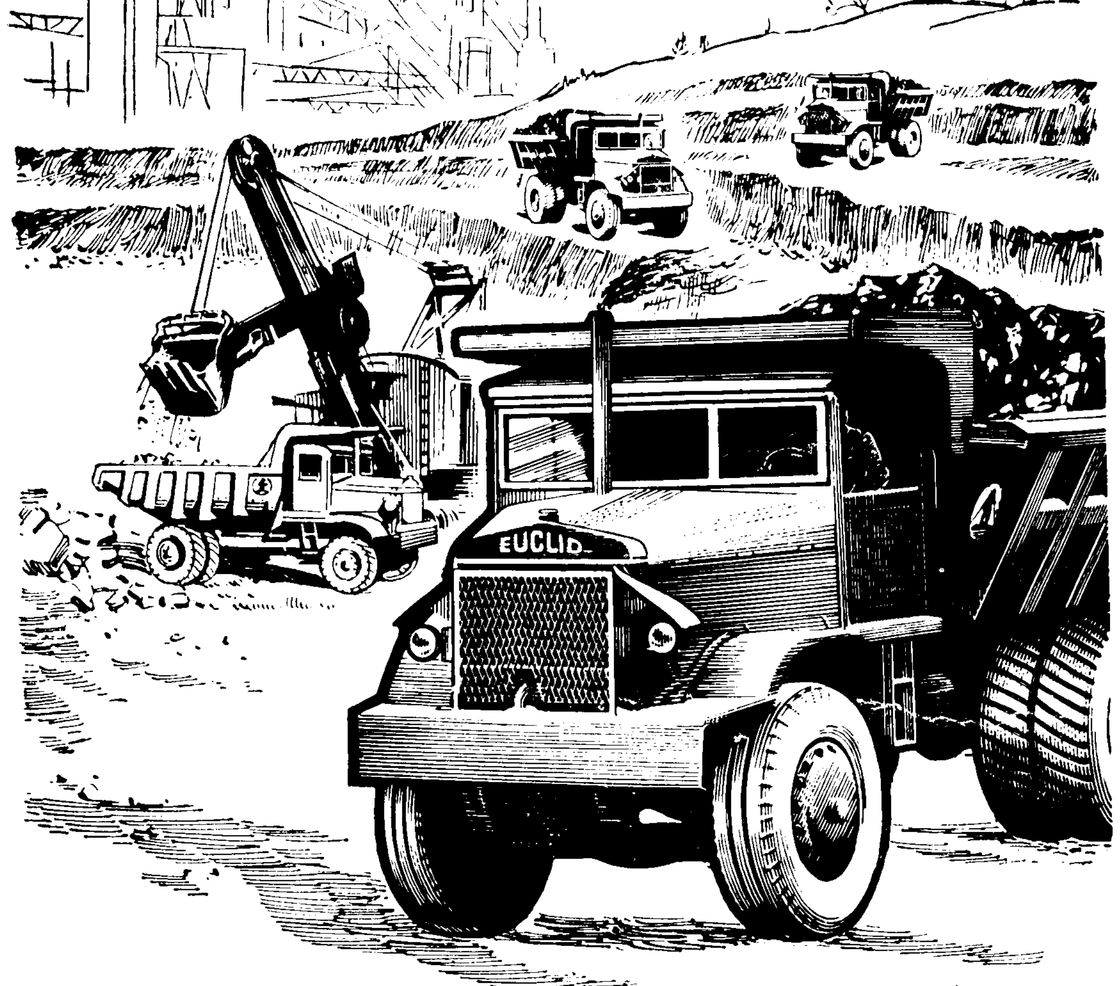
Euclids move **BIG** *loads from the pit*



The role of steel in modern civilisation is immeasurable. Without steel, industry would come to a standstill. The modern comforts we enjoy today would not exist.

Without coal there could be no steel. Consequently coal plays an equally important part in world progress.

To cope with the ever-growing necessity for more coal, strip mining has been developed ; so truck haulage has now become a major factor in the production and distribution of coal to meet thousands of industrial needs. In this new phase of coal production, Euclids are playing a leading part, moving materials efficiently and economically.

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