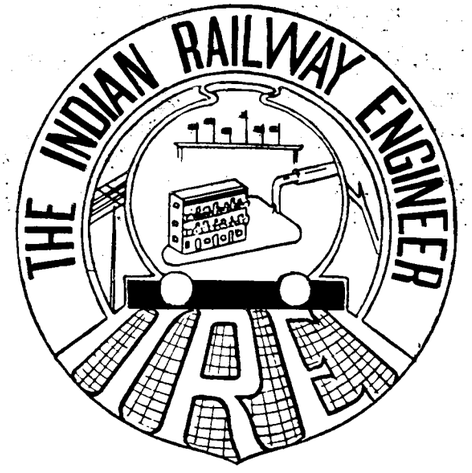

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The Requirements of Technical Personnel for the Railways' Second Five Year Plan

ALL plans look excellent on paper, but the rub comes in when they have to be implemented. The Railway plans for the Second five years period, are all concerned with expansion in many directions of this principal transport industry in the country, in which more than 900 crores of the tax payers' money has been invested.

More mileages of new track and extensive repairs to old tracks, more locomotives, more carriages and wagons, large workshop expansion schemes, new electrification schemes, further housing schemes, more and better amenities to passengers are all included, to be undertaken and completed between 1956–1961.

So far so good, but the rub comes in when we pose the questions "have the Railways got the necessary trained technical personnel to undertake this vast volume of work and if not, how then are these plans going to be executed efficiently, expeditiously and economically".

When all plans are reduced to their lowest common denominator they spell MEN. Men in the higher rungs of the Administrative ladder, men of broad vision and clear foresight, with a combination of high intelligence and unsevering determination to master all obstacles and see the plans through will be required.

Men will be required in the Executive grades on whom will fall the greatest burden, who must have the organising ability and capacity for hard and continuous work against adverse conditions and circumstances. Men, who will inspire confidence in their subordinates and not shirk their responsibilities and pass the baby for someone else to hold while they have a "CUSHY TIME".

Workers will be required in large numbers with sound knowledge and high degree of skill of their trades and plenty of physical stamina to perform the arduous duties which will be imposed upon them on long day shifts and perhaps on night shifts too. Workers will be in demand with discipline and high sense of loyalty to the administration, who will complete the daily task allotted to them cheerfully and without grumbling. Workers will be wanted who will not go on strike on flimsy pretexts and thus throw spanners in the works of the five year plan, with a view to sabbotaging it.

Undoubtedly, the Railways must be having some of these types of men already, but the question is, have they enough of them to undertake all the Railways' expansion plans and to complete them within the stipulated time.

During the 2nd World War the railways could keep going and still do a considerable amount of war work, but this was at a sacrifice of efficiency and even discipline and at that time the dilution of labour has reached such a pitch that any further introduction of untrained or poorly trained technical personnel would have meant a break down in the man power resources and probably a major disaster to our Railway system.

But then, during that period there was a war emergency and the Government had in their hands extraordinary powers and ordnances which they were not slow to use from time to time when things were inclined to go wrong and thus the railways were able to "muddle" through some how or other. Efficiency was at a discount and the slogan was "half a loaf is better than no loaf". No questions were asked regarding costs

or expenditure, provided the rolling stock carried both the phenomenal loads offering in Civil and Military personnel and goods and got to the destination on scheduled times.

War conditions cannot be applied to peace time working of railways and any plan which starts without an elegant sufficiency of trained technical personnel is doomed to failure and it is about time that our planners realised this, and gave it the serious attention it deserves.

The shortage of trained technical personnel is already being felt on all rungs of the Railway ladder and this when attempting to meet the potential increase in traffic of about 20%. Administrators of the requisite calibre are dwindling very rapidly and men in the higher executive grades are often found to be inexperienced because of their age and shortness of service. Supervisors in the subordinate grade are becoming more and more unreliable and are afraid to assert their position with their staff for fear of assault.

The whole of the Railways' burden, therefore, is being thrust on the weak shoulders of the few old but experienced men who have short time left before superannuation. Younger men taken on during the war from the streets have not in spite of all these years come up to the standard of workmanship which is required in Railway Workshops and Running Sheds. The result of this is that the Main Spring of the "Railway Clock" appears to be unwinding slowly but surely, without there being sufficient trained technical staff with solid experience to wind it up again.

If the Railways are to be equal to the tasks envisaged by our planners during the next 5 years, the clarion call of the moment appears to be intensive training and plenty of it at every stage of the Railways vast technical personnel and what is more there is no time to lose, the railways are already behind time.

More trade schools are immediately required at each of the Railways Workshop centre and each of the larger Running Sheds to train trade apprentices in their various trades. Schools will also be required to give refresher courses in batches to men already in service, who are reported by their Supervisors to be poor type of workmen. Technical training schools will be required for the apprentice mechanics, imparting to them a better and a higher standard of knowledge of their trade. The training of Supervisors will have to be intensified under the new T. W. I. Scheme and one centre at least will have to be established on each of the groups of the Railways. Training in management and production control appears to be necessary for Junior and Lower Gazetted Service Officers at the Universities or at Technical Colleges in the areas where these Officers may be working in the principal cities and towns. Finally specialised training in finance and administration on scientific lines will have to be given to those who are to be our potential administrators.

It will also have to be admitted that technical personnel cannot be trained and gain years of experience overnight and that while shortage in materials, deficiency in techniques could be made up by importing on a large scale, the same cannot be done with the technical personnel. However, the postponement of this very urgent problem or treating of it without the serious attention it deserves may have grave repercussions on the future working of our Railways which should be the duty of all concerned to avoid, if possible.

The Central Technical Information Service of the Indian Railways

By Y. K. Sharma *

ONE of the modern feature of the Railway Research Centre is its documentation and information service. This in addition to permeating its research activities and maintaining liaison with allied institutions in the country and abroad, promotes 'technical mindedness' by the publication of technical bulletins, research findings and developments thus providing a consultative service accessible to all railwaymen.

The various services of Information & Publication wing of the Railway Research Centre are :—

1. Publication of Indian Railway Technical Bulletin.
2. Publication of Technical Papers.
3. Research Reports.
4. Documentation Notes (Monthly).
5. Bibliographies.
6. Answering queries on specific subject in the field.
7. Supplying photo copies of articles from journal not normally available to the Railwaymen. It does not supply microfilms which of course is a cheaper method, because all railways do not have microfilm reader.

Let us start by describing how an information service operates. The first and foremost requirement is to know what is required or likely to be required and the second, how and where to obtain it. In this, intimate knowledge of the subject matter in all their specialised technical facets is as necessary as familiarity with the known and probable sources of information of a given type. The next main activity is Organisation of recording so as to make available at short notice the information collected Taken together all these comprise the substance of the methods and techniques of building up an information store-house. The fourth main activity is the dissemination of information in the form of abstracts, bulletins, reports and the like.

A technical information unit is usually, and basically, a literature reference service for research and other works. It is concerned with a vast body of well organised technical knowledge and its basic function is to keep track of and supply such knowledge when it is needed. The service may range from the checking of a reference to the provision of a regular and comprehensive bulletin of abstracts of current literature or to use the modern term, do the work of documentation; from finding out a new method of prestressing concrete to a critical review of the possibilities of a new industrial process; from finding the name of the supplier of a product to the presentation of certain statistics; from keeping research workers informed of current work in their subjects (and of relevant data from unexpected and unpublished sources) to drawing attention to new techniques which may initiate progressive developments. Other newer facets of an information service are technical publicity and research liaison. Information should not only flow into it but should flow out also to its potential users and workers. In a nutshell, it involves, seeking out, evaluation, interpretation and presentation of the information in such a way that it benefits those who need to apply it in practice. There has been a growing realisation that the volume of scientific work is increasing to an unmanageable extent; specialization, once afforded some relief but now the need is for contact between the specialist and an interchange of ideas for their mutual assistance and the world's benefit. An efficiently organised information service can thus form an important link in the progress of science and civilization.

I have used above the term Documentation. Let us here explore the nature and purpose of documentation.

Unfettered scientific knowledge requires that new discoveries and new theories should be made available immediately. For this purpose ordinary books and lists of books have limited utility. They can never be quite up-to-date. Science is advancing at such a tremendous speed that it is not possible for books to keep pace with it. The latest developments can generally only be known through periodical publications; that is why the scientific world attaches greater importance to periodicals than to books. Documentation is the process of collecting and classifying subject-wise all the records of new observations, distilling them and making them available for particular purposes. It is a process by which the documentalist is enabled to put before the worker the existing literature bearing on the subject of his investigation, in order that he may be fully aware of previous achievements in his subject and thus be saved from

* *Librarian, Railway Testing & Research Centre, Alambagh, Lucknow.*

duplicating the work already done. Documentation proceeds from the need to put in order the process of acquiring, preserving, abstracting and supplying as required, books, articles, reports, data and documents of all kinds. Without documentation the recorded observations are merely scattered items inaccessible and unusable which ultimately get buried in the great mass of scientific literature like a needle in a haystack.

The pillars on which a Documentation and Information Service rest are proper classification and cataloguing i. e. indexing of its holdings. The techniques of indexing differ in form depending on the way in which the principles of subject analysis are applied. Each form has its own particular advantages and field of use; much work still remains to be done to define the appropriate field in which each technique is applicable. But this evaluation will be easier if we first gain a clear understanding of the principles which are to be applied. Each indexing technique should therefore be judged from the point of views (a) Does it apply the principles so far discovered, consistently and adequately? (b) Does it introduce any new principle and is this of value? (c) Is the form which the technique takes appropriate to the particular end in view?

For documentation centres as well as for public and private collections of bibliographical data and records, a standardized classification, especially for international collaboration, is essential. A standardized classification besides facilitating the mutual exchange of data, has the advantage that classification once done can be utilized by other libraries etc. again. In general standardization has in view the abolition of needless diversity and is in this respect of particular value if exchangeability of reference is required. Thus if different services, or institutions have to exchange classified date, standardization of classification secures that the self-same data do not have to be classified afresh. Take the example of outside bibliographical institutions in the field of Railway Engineering: "The Railway Engineering Abstracts" published by the Institution of Civil Engineers (London) the "Journal of Railway Engineering Research" published fortnightly by the Japanese National Railways and some other foreign periodicals of this Class including the Documentation Bulletin of the International Union of Railways (Paris) bear the appropriate Universal Decimal Classification number. This saves the labour of classification—a tedious process—in other centres over again and establishes a continuity of identification without ambiguity.

Two other somewhat simpler standard systems of classification were at one time considered but eventually rejected in favour of the Universal Decimal Classification. One system, the Dewey Classification, has found widespread application in Universities and Institutions of higher learning. In point of fact the U. D. C. has grown out of the Dewey system and the growth and expansion is in itself proof of the Universality of the later system.

The second system is particularly adopted for Railway Technology and administration: it was evolved by the French National Railways and is in use side by side with U. D. C. at their Documentation Centre in Paris. A study of its scope and nature has shown that it is more suitable for adoption in libraries where skilled librarianship assistance is not available to library users. Its greatest practical utility lies in the convenience of arrangement of broad subject headings in the specialised science of railway engineering, operation and management: at the Research Centre at Lucknow, these principles have been exploited in the lay out of published catalogues—for instance the Catalogue of Technical Papers published by the Railway Board.

Colon classification—an analytical synthetic classification system—which is equally helpful as U. D. C. for documentation work could not be adopted in this Centre because its schedules as regards Rly. Engineering have not yet been developed to the extent they are in U. D. C. Work should, in fact, be done for expanding colon schedules for specialized libraries.

The U. D. C. satisfies the demands, enumerated above, for a subject analysis. It is designed for use in the collection and dissemination of information on any subject, or any sub-division, however detailed. Other advantages of the Universal Decimal Classification arise directly from its universal character. When a specialist is drawing up a detailed classification for the arrangements of documents in his field of work, the Universal Decimal Classification will be found to work smoothly. Furthermore it is likely that by its use, "the specialist will be drawn into more proper relation with neighbouring fields than otherwise". In proportion as particular specialized fields display more coherence and relation to one another—and that is characteristic of contemporary trend of science—so will the specialist have to pay more attention to allied fields. It is just these allied fields which have often caused a deadlock in "individual classification" which grew at one time in alarming fashion and came collectively under the term "various" and eventually carried more than the original logically extended systematic part of the "individual classification". Another advantage is its decimal symbols which offer mnemonic advantage over symbols made up

(Continued on page 8)

HOUSES FOR RAILWAY WORKERS

By Our Special Engineering Correspondent

RAILWAYS are the biggest national assets of India. Nearly a million men work in the vast network of 35,000 miles of railways spreading out to the four corners of our country. Many railway workers live in their own houses in the suburbs of cities and towns and come to their places of work by train driven by steam or electricity. Others live in rented houses in cities proper or very near to their places of work and attend their duty on foot, cycles, buses or tram cars. However, leaving aside the men who have made their own arrangements, a large number of workers are to be housed in railway quarters. Essential staff whose services may be required at any time of the day or night, or whose daily services are directly required in connection with running of trains are expected to live in railway quarters. Due to shortage of houses all over India and due to exhorbitant rents demanded by land lords, other classes of staff are also very keen to get Railway quarters.

At the end of 1954–55, it has been roughly estimated that 9,50,000 men work on the Indian Railways. Number of Railway houses are 3,30,000. The Railways are building at the rate 10,000 houses per year. It is expected that with the building of 1,00,000 houses in the next ten years, the housing problem will be considerably relieved. Two aspects of Railways' building programme will appeal to the country, namely, 99% of the houses are for lower income groups and 10% of the amount spent on building new houses is annually spent improving old quarters and providing amenities to them.

Indian Railways have celebrated their centinary and from a study of the design of existing quarters and the Building Registers maintained by railways, it becomes apparent that they realised very early the necessity of standardising the design and cost of houses for different pay groups of staff. Each railway evolved its own design of type plans and built according to them. With the progress of time, railways revised their type plans and tried to improve the design within the money available for building a particular type of quarter. The improvement mainly consisted of improved lay-out, better ventilation and more amenities. A comprehensive study of industrial housing in India which included railway housing also, was made by the Mittra Committee appointed by the Committee recommending A, B, C, D, E, F type quarters for different pay groups of workers. The outstanding feature of the Report was the evolution of the A type quarter with two rooms, verandah, kitchen, bathingplace, sanitary latrine, for the lowest pay group which are known as Class IV staff on railways. The railways started building these quarters but very soon realised that country's resources in money and materials could not afford to give two-roomed quarters to Class IV staff. Mittra Committee's recommendation could not be implemented as the Committee did not assess the resources of the country. The Report was good in so far as it indicated ' what should be done ' and not ' what could be done.'

The next attempt to standardise different classes of houses for different pay groups of occupants is the Expert Committee's Report produced by Badhwar-Williams-Puri in 1952. This pamphlet is the most comprehensive summary of the present day situation and is a mine of information on the subject. Based on this report and after taking into consideration the railway problems, the Railway Board standardised the accommodation and ceiling costs of quarters for different pay groups of Railway staff. Some of the main details are given in App. I.

(*Continued from page 7*)

of combination of letters and Arabic or Roman numerals. There are definitely some defects in this system but on closer examination it will be found that these criticism apply to any classification.

Classification is an art requiring knowledge not only of the classification but also, above all, of the matter to be classified. It is necessary always to keep in mind that the aim is not merely to specify the contents of a document but to be able to produce it as quickly as possible when required. The classifier should continually ask himself, what are the needs of those for whom he is doing the work, and what will presently, have to be looked for and where.

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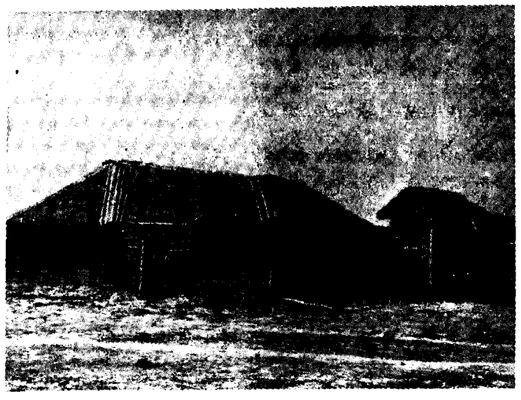
Two roomed Post & Panel Type Quarters.

Two roomed Assam Type Quarters.



Two roomed Mat & Thatch Quarters.

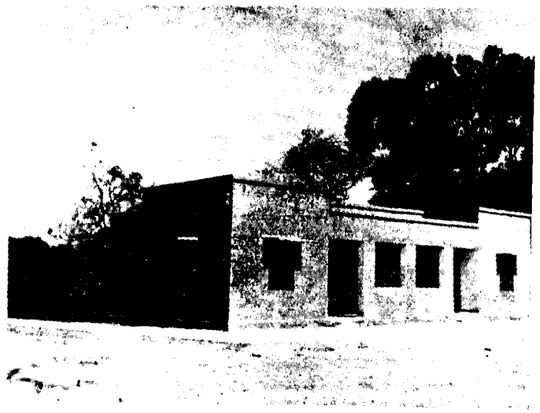
Two roomed Hollow Concrete Block Quarters.

International Exhibition on low cost housing held in Delhi gave an idea to the Architects, Engineers, Contractors and the Public, how vast was India and varying its climatic conditions and how the country was trying to evolve the design of low cost two-roomed houses suitable for different areas of the country.

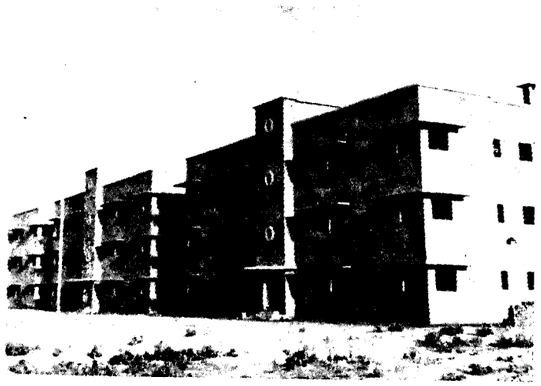
It is not the intention to go into the details of lay-out, design and construction of houses for railway workers. Certain fundamental facts which are at times forgotten have emerged from the experience of handling the problem of large scale house construction on railways. These will be briefly stated.

STANDARDISATION

Climatic conditions are so different parts of India that it is not advisable to over-standardise the lay-out of colonies, orientation of quarters, arrangements of rooms and wall openings, specification of materials and workmanship. It is but natural that men entrusted with the task of producing a Building Code for India will be influenced by their own experience gained in particular areas of the country and therefore it is necessary that men from all parts of India should meet together to discuss the subject of house design. Taking for instance the case of only one Indian Railway out of the seven, it may be stated that :—

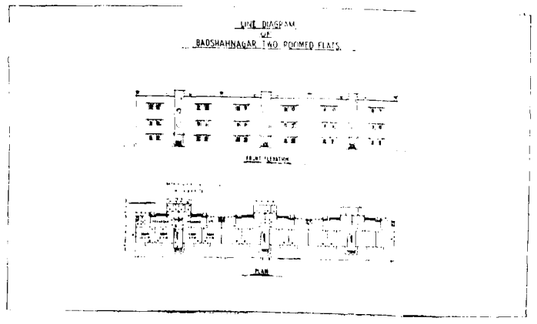


Two roomed Pucca Quarters.



Two roomed Three Storeyed Flats.

Two roomed Katihar Type Quarters.



(i) the direction of prevailing wind changes from North–South to East–West.

(ii) rainfall varies from 15" in a year to 200" with 15" in a night.

(iii) soil conditions vary from pure alluvium to Himalayan loose rocks.

(iv) regions lie from completely outside seismic zone to zone with G 3 seismic factor.

Design, lay-out and specification must cater for these varying conditions.

PRE-FABRICATION

There is no magic in the world pre-fabrication. All houses are pre-fabricated to a certain extent. As for instance in an orthodox type brick building, the bricks, the doors and windows and roof joists are pre-fabricated. Attempts in India to produce fully pre-fabricated houses have not yet proved successful. Apart from the question of the suitability of materials used in pre-fabricating various parts of a house, transportation problem from factories to sites of construction, local availability of skilled and semi-skilled workers for assembling the parts and finishing the house and lastly the suitability of such houses for the people who will occupy them should be seriously considered.

CHEAP AND QUICK HOUSES

If floor and plinth areas, ancillary services, specifications, cost of labour and materials are fixed, ingenuity of Architects and Engineers cannot reduce the cost of a house by any appreciable extent. Many non-technical and even technical men try to misrepresent facts to the public in advertising cheap houses. They cut down ancillary services, lower specifications, assume lower cost of labour and materials, ignore supervision and contingent charges.

Advertisement like "a house in two days" should not hood-wink the public. No pucca house using traditional Indian materials can be built in two days but it is not at all difficult to built 200 or more houses in a year which will give a house in less than two days.

Examples of houses built and now being built by one of the Indian railways will give the readers an idea how the Indian Railways are trying to solve their house building problem taking into consideration the local conditions but always keeping in view the principles laid down by the Railway Board.

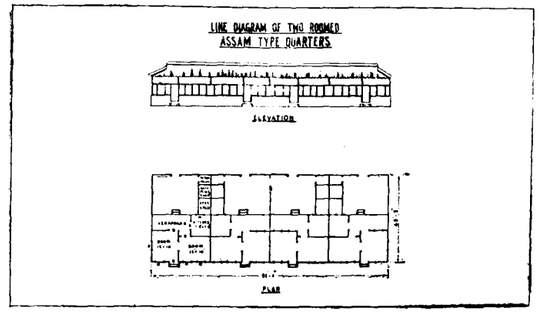
LAY-OUT OF COLONIES

Public are familiar with lay-outs of Railway colonies where houses are arranged in rows after rows without much open space between them and with doors or latrines facing the railway track. These days are gone. Large colonies have laid out by Railways in the shape of open or closed polygons, circles and arcs, cul-de-sac, etc. and with parks, childrens' play ground, gardens, etc.

MAT AND THATCH HOUSES

There are a number of riverine ghat stations where the railway transhipps goods and passengers from and to river crafts. These stations shift from site to site on the river bank to maintain shore connection with steamers and barges which can only safely berth in sufficient depth of water and against river bank which is not eroding. Some of these shifts are to be planned at short notice and involve construction of several miles of railway line with a large number of houses for the staff to live and work at the ghat site. No pucca construction is possible as the sites are liable to heavy erosion by the river and as the time available for construction is very short. Temporary houses are built of bamboos, mats and thatching grass These houses using no wood or iron materials can be very quickly built, easily dismantled and re-erected with light repairs in a new site. They are nice and comfortable to live in but fire risk is great as all materials used are inflammable. Many

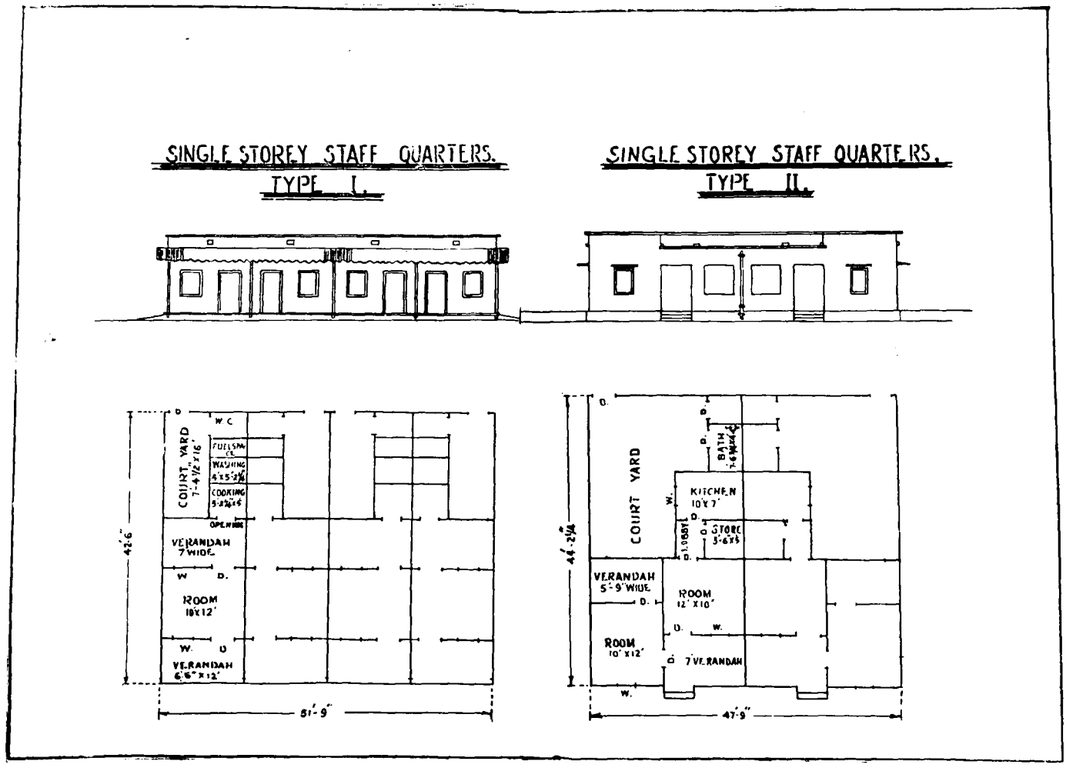
modifications and improvements can be made to these quarters. Roofs can be made of layers of split bamboo, posts of wood, walls of nicely woven split bamboo, doors and windows of wood and plinth and floor of pucca brick work. These will greatly improve the appearance, strength and durability of these quarters but the main problem of fire-proofing them still remains. Theoretical suggestions of boiling the whole lot of bamboos, mats, thatching grass, string, etc. in fire-proofing solution before use or spraying the completed structure from ridge to floor, inside and outside with fire-proofing solution, has not proved successful in action or cost.

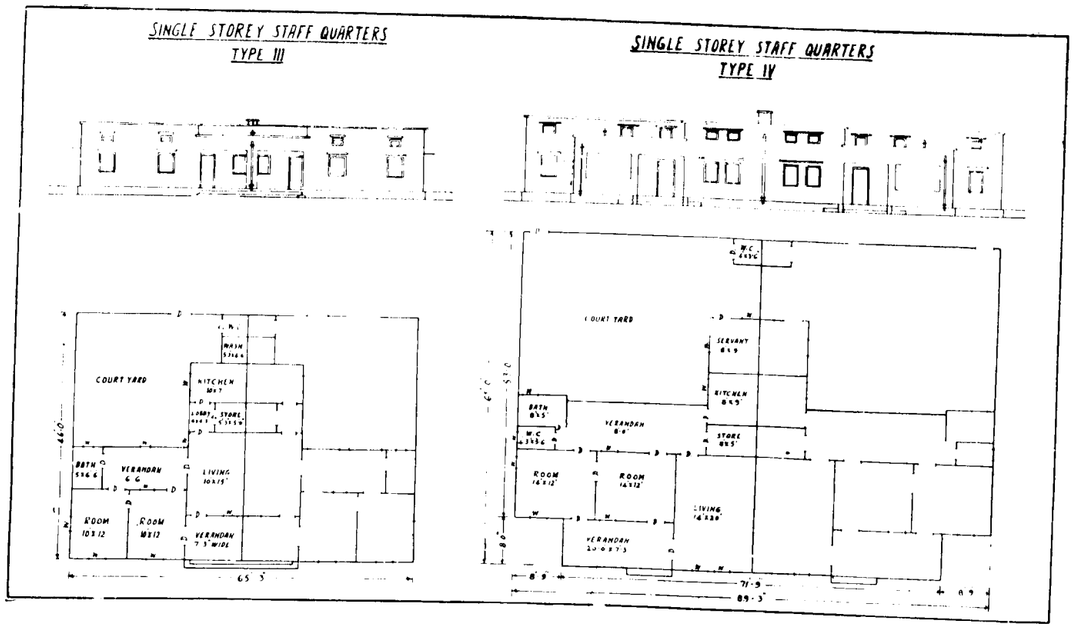


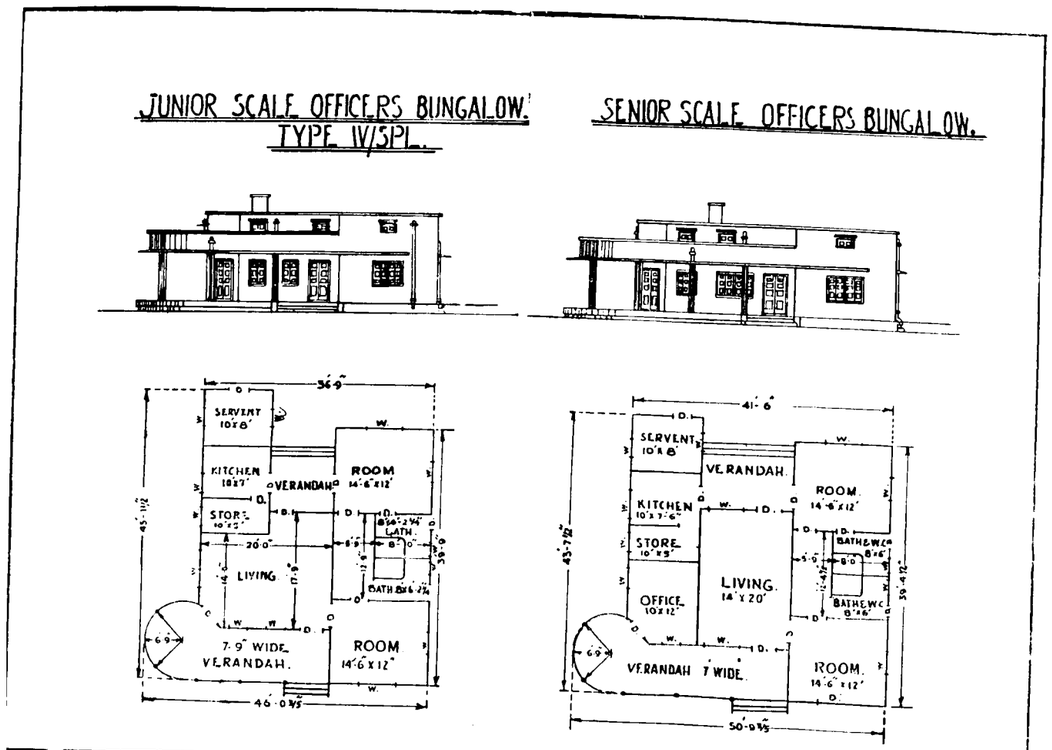
Indian Engineers must solve the problem of mat and thatch house, as they must solve the problems of bullock carts and mud track.

ASSAM TYPE QUARTERS

Assam gets very heavy rain and most of its area is situated in seismic zone of great intensity. Bricks, cement and steel materials are difficult to get and expensive. Asbestos or corrugated galvanised sheet sloped roof, half brick pucca wall upto window sill level, ekra (a kind of locally grown reed) or split bamboo walling in wooden frame and plastered inside and outside, wooden doors and windows and pucca floor and plinth produce comfortable types of quarters suitable for the area. Sloped roofs quickly drain off rain water, light walls, posts and roofs stand







earthquake shocks quite well and repairs are easy. Red or green paint on the roof, green paint on the wooden wall frame, white wash inside and light colour wash outside make the quarters look pretty in the surroundings of ever greens.

POST AND PANEL TYPE QUARTERS

Railways in the past have used post and panel type of construction but an energetic Firm have constructed a number of this type of quarters in a place called Siliguri, where good sand and shingle are plentiful in the Mahanarda river close by. Outside walls are double panelled with an air gap in between but partition walls are of single panel. All panels are vibrated and the cement concrete produced is quite good.

KATIHAR TYPE QUARTERS

Katihar is a big railway junction and a civil town. Rainfall is moderate and bricks are plentiful. A type of quarter with single sloped asbestos sheet roof, walls of brick work in mud mortar, jambs and soffits of pucca brick work, inside plastering and outside pointing, pucca floor and plinth has been evolved for the area to get pucca quarters at a comparatively cheaper cost.

HOLLOW CONCRETE BLOCK QUARTERS

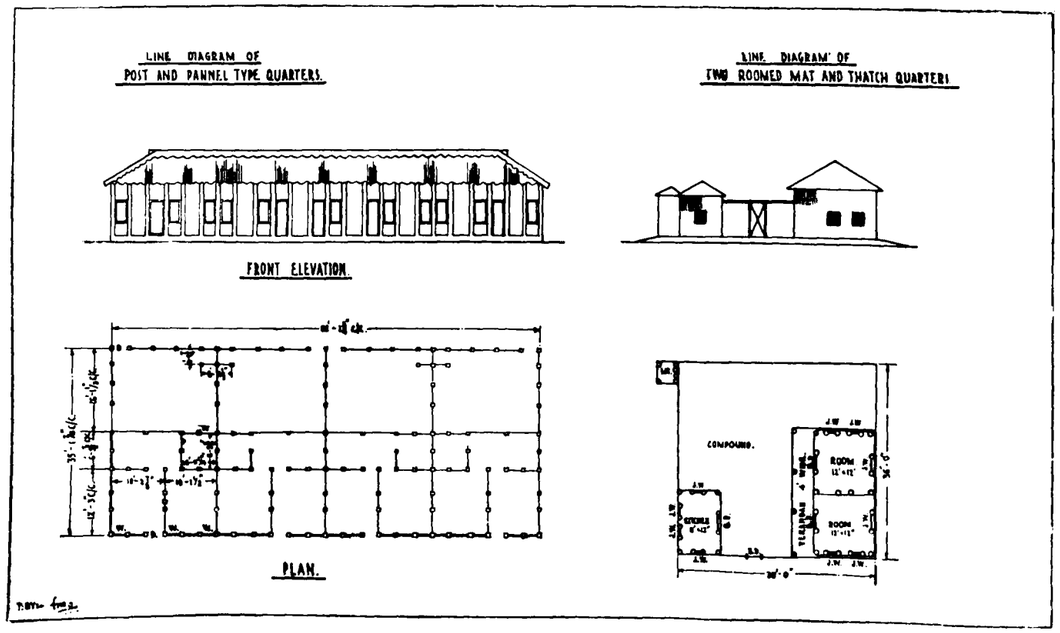
Over a large portion of the railway under consideration bricks are difficult to manufacture but sand and shingle are easily available in the hill streams abounding in the area. Large scale construction of two-celled hollow concrete blocks 16″×8″×8″ was adopted. Walls are made of hollow concrete blocks and roofs of sloped asbestos or corrugated galvanised sheets supported on old light section rails. Experience has shown that where rainfall is heavy, at least one face if not both of the walls should be plastered.

PUCCA BRICK QUARTERS

Traditional type of pucca quarters with brick walls in limesurkhi or lean cement-sand mortar, jack arch or reinforced concrete roofs with lime terracing for waterproofing, sal and other wood doors and windows still hold the field over large areas of the railway.

MULTI-STOREYED QUARTERS

By far the largest number of railway quarters are single storeyed but in towns and cities where land is difficult to get and expensive, the railway has adopted multi-storeyed type construction. Modern tworoomed flats for class III staff have used reinforced concrete



roofs, stair cases and anti-seismic bands, brick work in cement mortar for walls, wide windows and sanitary arrangements.

Appendix II shows the sketch plans for tworoomed quarters of the types mentioned above except multi-storeyed flats. It also gives the designs of quarters adopted by the railway for Type I, II, III, IV, IV (Special) for Assistant Officers (pay scale Rs. 300—600) and also a plan for Senior Scale Officer with pay scale of Rs. 600—1150/- per month. Some of the quarters have been illustrated in photographs.

A house is a piece of work for which individual likes and dislikes are very strongly felt and expressed. Unfortunately for mass production houses must be standardised into types. These two views are difficult to reconcile. Meticulous researches into orientation, heights of roofs, water proofing of roofs construction of floors, placing and specification of doors and windows are not likely to produce unexpected results which the local knowledge and tradition have not achieved. More attention should be paid to the layouts of colonies, development of sites provision of services. Problems of a strong floor, a water proof roof, durable doors and windows at moderate cost are worth studying but it must be remembered that the specifications and not necessarily the finish, adopted in rented houses must be higher than those adopted in houses built for the owner's use. Similarly the lower the type of the house the higher should be the specifications as these are expected to be more roughly and intensively used than higher types of houses. This suggestion is contrary to present day practice which uses lower specifications for lower types of houses.

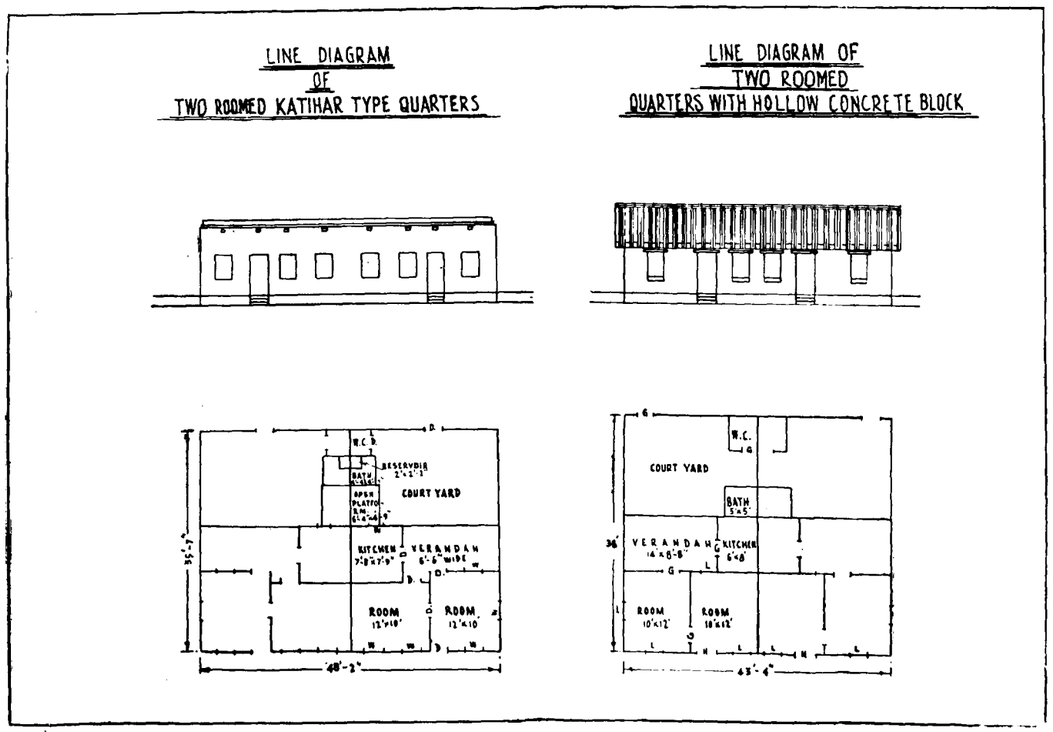
APPENDIX I

STAFF QUARTERS

Scales of accommodation

TYPE I One main room 120 sq. ft. in area with inside verandah and a lean-to open front verandah (without trellis), cooking place, latrine, washing place and courtyard.

Plinth area approximately 300 sq. ft.



TYPE II A 2-roomed quarter with a kitchen, inside verandah and an open lean-to verandah in front of one room only (without trellis), bath, store, individual latrine and courtyard. Each main room should be about 120 sq. ft. in area.

Plinth area of covered space should be approximately 625 sq. ft.

TYPE III A 3-roomed quarter with internal and external verandahs kitchen, store, bath, individual latrine and courtyard. Approximate size of living room 150 sq. ft. and 2 bed rooms 120 sq. ft. each. The plinth area of covered space should be approximately 900 sq. ft.

TYPE IV A 3-roomed quarter with one large living (dining/sitting) room and two bed-rooms with front and inside verandahs, kitchen, store, bath, latrine and one servant's room. Approximate size of living room 280 sq. ft. and 2 bed rooms 170 sq. ft. each.

Plinth area of covered space should be approximately 1450 sq. ft.

Note. Type IV flats for Assistant Officers should have somewhat similar accommodation but with a separate bath room for each bed room.

In case of double-storeyed quarters the above scale of accommodation should be suitably modified.

Ranges of costs for the building portion only.

The following ceiling unit costs, based on Delhi area rates, are indicated for each of the above types :—

Type of quarter	*Single storeyed* Rs.	*Double storeyed* Rs.
TYPE I – One room with lean-to 6′ wide external verandah	2,400	3,000
,, II – two rooms	5,000	6,000
,, III – three rooms	7,000	8,500
,, IV – three rooms (with one bath room)	12,500	15,000
,, IV flats with two bath rooms for officers	—	18,000

Range. These costs will be subject to adjustments according to the local building cost indices.

Note. Cost of ancillary services will be extra.

Scales of pay of staff to whom these various types should be allotted.

TYPE I – All Class IV staff (may be allotted temporarily to Junior class III staff where necessary).

,, II – For all class III staff on the scales of pay whose minimum is below Rs. 200 p. m.

,, III – Rs. 200 to Rs. 350 range of pay.

,, IV – Upto Rs. 500.

Standard for the development of sites and scale of fittings.

GENERAL

(i) The area where the quarters are sited should be cleared, terraced or levelled, and well drained and the boundaries should be suitably fenced or demarcated with hedging etc. All-weather approach and service roads should be provided for use before the quarters are occupied. To economise in land, Type I quarters should be spaced in rows of 4 unit blocks, allowing about 20 ft. between adjacent blocks, and about 30 ft. in front and 30 ft. clear at the back of each block. Types II & III should usually be built in 2-unit or semi-detached blocks and Type IV should be detached units where space permits.

(ii) At locations where the cost of land is high, the construction of multi-storeyed blocks of quarters should be adopted.

(iii) *Water supply.* Where piped water supply is available or can be undertaken at reasonable cost, water taps should be provided on the following scales :—

TYPE I – One $\frac{1}{2}$″ tap should be provided inside each quarter.

,, II – One $\frac{1}{2}$″ tap should be provided inside each quarter.

,, III – Two $\frac{1}{2}$″ taps should be provided inside each quarter, one in the bath room and one in the kitchen.

,, IV – Three $\frac{1}{2}$″ taps should be provided inside each quarter one in the bath-room, one in the water closet and one in the kitchen.

(iv) *Drainage :* Adequate drains should be provided for carrying away sullage and storm-water from all quarters and the satisfactory disposal of the effluent from areas where quarters are constructed should be ensured before any buildings are constructed.

Also where water-borne or under-ground sewerage systems exists, the drainage of the areas where the quarters are proposed to be built should be connected to such systems before the quarters are occupied.

(v) *Electrification :* Where electricity is available, street lighting of the areas where the quarters are built, should be provided before quarters are occupied.

The scale of electrical fittings for the various types of quarters should be as under :—

	Light points	*Plug points*	*Fans*
TYPE I	2	—	—
,, II	5	1	—
TYPE III	6	2	1
,, IV	9	4	3

(vi) *Sanitation :* Provision for the removal and disposal of night soil and refuse from areas where the quarters are built should be made before quarters are occupied. Flush system latrines should be provided, where a water-borne system is available.

Cost of development : The costs of development of areas where staff quarters are to be built will vary with the locality and the terrain. Generally speaking, 5% of the cost of buildings proper for external sanitary and electrical connection and another 5% for other development purpose, like levelling roads, etc. should be adequate. For large colonies, where virgin areas have to be developed or in places where quarters have to be built in small numbers this percentage may go up to 25%. Development of sites should be based on long term planning.

Training of Chakki River on Mukerian Pathankot Railway Construction

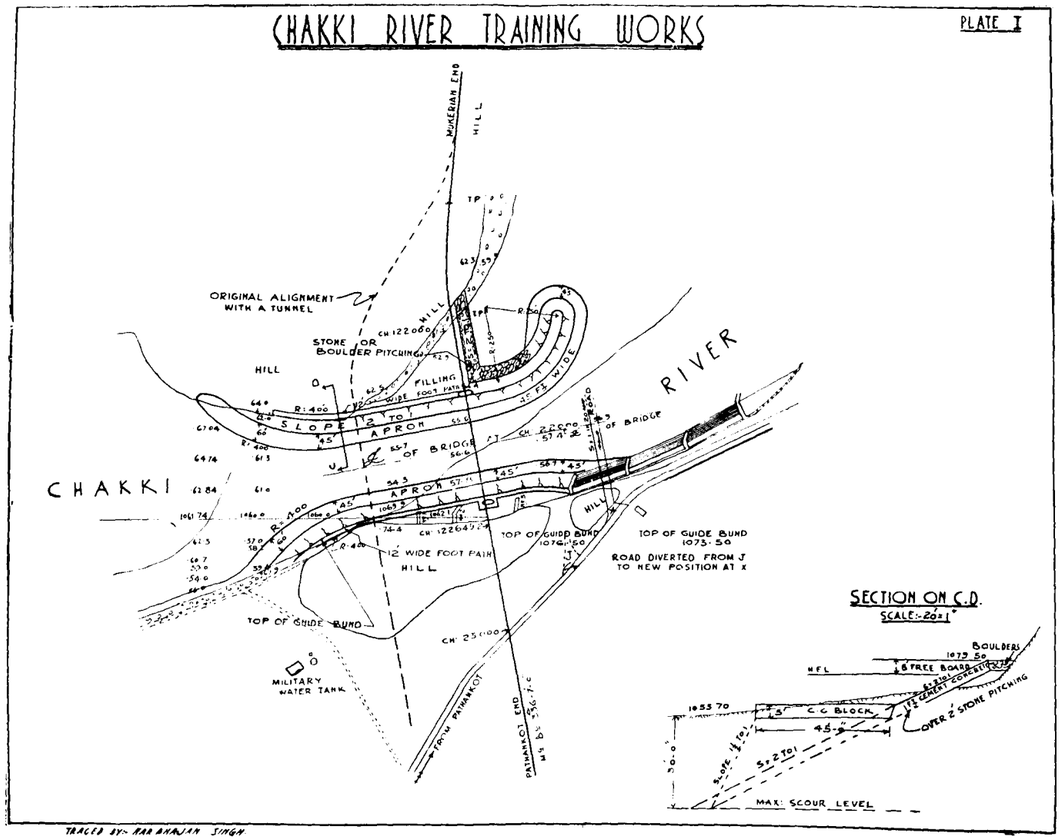
By Gurdial Singh, A.M.I.E., A.M.I. Struct. E.

INTRODUCTORY

THE partition of the country in 1947 necessitated the extension of the Jullundur Mukerian Railway line to Pathankot which became the gate-way to Kashmir. This connection had been studied during the British period but given up due to the heavy cost involved in building a bridge over the Beas River. With the easy means of communication then existing with Kashmir, the line had only a local interest and its construction was not considered justifiable. The new line under the new conditions forms a very important link in our communications with Kashmir. Its construction, however, involved Engineering problems of a very intricate and interesting nature. The Chief of these were the bridging and training of the Rivers Beas and Chakki. It is proposed to deal with the Training Works of Chakki River only in this paper.

THE CHAKKI

The Chakki is a hill torrent, which rises near Dalhousie and flowing through the hills enters the plains at Pathankot. On its way, its flow is augmented by other hill streams and nullahs.



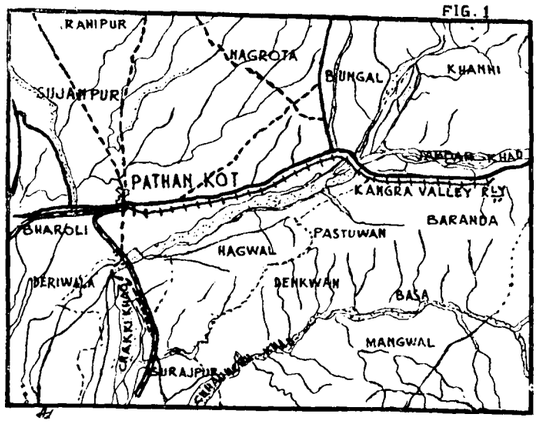
BAN-GANGA

The Chakki is a very swift running hill torrent and when in spate has velocities ranging upto 25 ft. per second. The floods in it are very sudden due to steep declivity and during the rains its crossing is extremely dangerous as a wall of water rushes down suddenly without warning.

In old times the Chakki used to flow past the Promonotory of a hill and branched into two parts after crossing it, one branch falling into the Ravi and the other into the Beas. When the upper Bari Doab Canal system was built, a cut was made in the hill and the branch flowing into the Ravi closed to prevent its cutting across the new Canal system. This cut developed to a width of about 350 ft. in the narrowest part of the gorge and training works were built by the Irrigation Branch in the form of spurs to prevent the river causing further erosion on Pathankot side as shown in Plate. I. These measures diverted the main current towards the left, where it caused extremely heavy erosion of the hill sides causing slips, which came dangerously close to the Indora road then running on the hill side. It was decided to bridge the river in this narrow gorge. The approach, however, presented difficulties and at one stage it was seriously contemplated to drive a tunnel along the axis of the hill on curves to reach the narrowest part of the gorge. The hills here are, however, of recent formation and consist of clay and boulders unsuitable for constructing and maintaining a tunnel at a reasonable cost. A design was, therefore, prepared by extending artificially the narrow neck of the gorge and carrying the line on hill sides through comparatively light cutting to provide a suitable approach to the bridge built on this artificial extension. This design was finally adopted and is shown on Plate I along-with complete details of the training works.

About 8 miles upstream of the new crossing, the Chakki is crossed by the Narrow Gauge line to Jogendranagar. The existing bridge here has 17×40′, 2×80′ and 6×126′ 6″ spans. This bridge is not well situated as being located about ½ mile below the confluence of Jabbarkhad and Chakki as shown in Fig. I., the two nullahs tend to maintain their directions during floods due to high shooting velocities. There is consequently very heavy turbulence leading to deep scour. The spans at the two ends only function effectively while the central ones get silted up. The road bridge just upstream of the Railway bridge originally consisted of 20 spans of 40 ft., span arches, but later 10 more girder spans had to be added. In 1933 the right side scoured so deep that five spans fell down and had to be built with extra deep foundations. This example illustrates the necessity of

FIG. 1



a thorough study before bridging hill nullahs to avoid wasteful expenditure.

The maximum discharge of the Chakki, as ascertained by the Irrigation Branch is approximately 120000 cusecs. This agrees with Ingliss' formula for discharge $Q = \frac{7000A}{\sqrt{A+4}}$ for the catchment area of 300 square miles. The gorge at Pathankot obviously acted as a flume to pass this discharge. The training works on the Chakki are merely the extension of this flume to a length of about 550 ft. down-stream for obtaining a satisfactory approach to the Bridge along the hillsides. This has been achieved by blocking the river bed on Mukerian side with earthwork and building two parallel bunds. It is to be noted that these bunds are not the familiar Bell's Bunds, which project into the Khadir of the river to produce still water areas behind them for protecting the approach bank, but merely the side of the flume. The chakki Training Works are, therefore, not in the same category as the Bell's bunds.

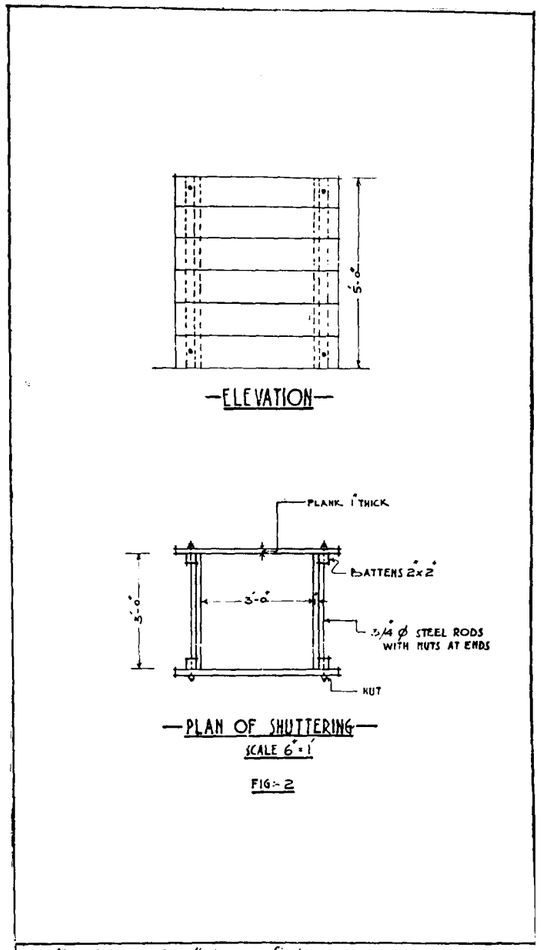
It is obvious that in order to contain such a turbulent stream within the two banks, they must be very heavily armoured. It was necessary to form an estimate of the deepest scour that may be expected in the gorge. The calculations to arrive at the scour, the size of the apron, etc. are given in Appendix I. The width of apron was kept 45 ft. on the straight and 60 ft. on the curved moleheads, its thickness being kept 5 ft. throughout. The usual type of apron adopted in alluvial rivers with low velocities consisting of one man stone weighing about 120 lbs. would have been of no use to resist such a swift current. It was decided, therefore, to use cement concrete blocks. The formula usually adopted for determining the diam.

D of stone, which can be moved by a current of velocity V ft. per second is given by $V = 5.67\sqrt{G \times D}$, where G is the specific gravity of the material. For a mean velocity of 15 ft. per second observed in the Chakki, this will give D = 3.4 ft. The actual size of block adopted was 3′×3′×5′.

The Author is not aware of any other reliable formula connecting the velocity of the current with the size of block that can be moved by it. A very interesting set of experiments were carried out in Egypt by Butcher & Atkinson vide Proceedings of the Institution of Civil Engineers Vol. 235. No final formula was derived for the size of blocks, but it was established that the immobility of a block I varies as (S—I) L, where 'S' is the specific gravity of the material of the block & 'L' the side of a cubic block. A value of 4.5 for I appears to be suitable for velocities upto 15 ft. per sec. A block size of about 4 ft. will, therefore, be suitable.

The shape of the guide bund on the down stream side of the river was under controversy for some time. At first it was proposed to lay the apron below the hill side and to pitch its slope in order to let the current stick to its existing course. Finally it was decided to adopt the usual shape of a curved mole-head for the guide bunds to reduce the erosion of the hill sides at Mukerian end to ensure safety of the line.

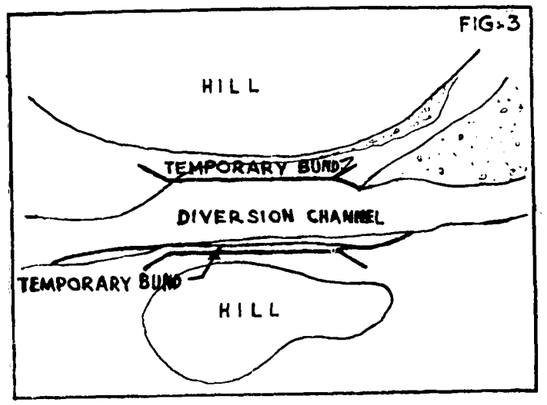
The work on the Training Works was started in October 1950. As the Contractors could not obtain steel, the form work was made of timber with ties of steel rods, as shown in Fig. 2. Shingle and sand was plentiful at the site of work. Due to heavy movement of boulders along the bed giving rise to abrasion, 1 : 3 : 6 concrete was used at first. Later on a leaner mix of 1 : 4 : 8 was adopted for economy. The total amount of concreting involved was about 6½ lacs cft., and the total amount of earth work about 34 lacs cft. The Contractors, M/s. Pathankot Bajri and Stone Co. had six concrete mixers of 3½ cft. capacity. Besides this some hand mixing was also done on concrete platforms. The maximum progress attained was 5600 cft. concrete and 22000 cft. of earth work per day. There were however, violent fluctuations in these rates due to interruptions caused by labour shortages rains and floods. Originally a target of 9000 cft. of concrete was aimed at, but subsequently it became clear that sufficient resources could not be mustered for this progress and the work would be left incomplete and at the mercy of floods unless a drastic change was made in the design. The slope armour, therefore, which originally consisted of 3 ft. thick concrete was cut down to 1 ft. thick concrete cover over 2 ft. of boulder pitching. The concrete cover



was provided upto a height of 1 ft. above the H.F.L. only, the remaining height to top of bank being covered with boulder pitching alone.

It was intended originally to leave a space of 1 in. between the concrete blocks. It was later increased to 3 in. inview of the difficulties encountered in practice. Even this clearance, however, was found to be unworkable especially with wooden shuttering. A clearance varying from 6 in. to 9 in. has actually been kept at site.

It was necessary to divert the flow of the river through a central channel in order to complete the work on



Mukerian side as shown in Fig. 3. There were, however, rains and minor floods, which destroyed the temporary closure bunds and diverted the current to its old course again.

As a result damage was caused to earthwork. Unexpectedly heavy rains in March and May brought down medium floods, which violently disturbed the incomplete apron at the down-stream end on Mekerian side. A few blocks were bodily carried forward. These natural causes gave a heavy set-back to the work, as the contractor's concrete mixers and a tramway line laid for tip wagons and the small locomotive for hauling them were washed away. The locomotive suffered a good deal of damage and was rendered practically useless for the rest of the work.

The completion of the earthwork was the major problem. The soil consisted entirely of shingle, gravel, and houlders with patches of soft rock. During hot dry days it was very hard to work it. Men climbed on hill faces and loosened earth from there perched precariously on the bare rock faces. In spite of their best efforts, the contractors at their quoted rate of 210% above the schedule rate of Rs. 10% cft. for excavation in shingle gravel and houlders and Rs. 15/- % cft. for soft rock, could not muster sufficient resourses for completing the earth work by the 30th June, 1951. The down-stream curved mole-head was in a very vulnerable condition, when the rains started. This gave a great anxiety to the author. When a minor flood occurred in July, the water started seeping through the Mukerian end mole-head. Immediate measures were taken to add

shingle and houlders on the side to check a tendency of piping action through the thin incomplete bank. Fortunately, however, no major flood came in the month of July and by the end of that month, the work had advanced sufficiently to place it out of danger. A reserve of wire trungars and pitching stone was, however, constantly maintained to meet any emergency that may arise.

The first heavy flood occurred on the 1st of August, when the water rose to a level of 1067 at the centre line i.e. only 3 ft. below the designed H.F.L. The chakki when in flood presents an awful spectacle, waves 3 to 4 ft. high rise in the stream and the grinding of heavy houlders on the bed can be heard as far back as the town of Pathankot, which is at a distance of about a mile. When the floods subsided, the scene had absolutely changed. The neat rows of apron blocks, which only the night before were being used as a pleasant promenade by the people from the town were thrown in utter confusion. In fact it appeared, as if some huge giants had walked with pitch-forks in their hands, and upset every-thing. As already stated concrete blocks $3' \times 3' \times 5'$ and at several places $4' \times 4' \times 5'$ had been used for the apron. These were bodily carried away by the fierce current. Immediate steps were taken to strengthen the apron, where necessary, by throwing wire net trungars filled with houlders. These sausages were 3 ft. in diameter and 6 ft. long. The course of the stream was radically altered and the main current instead of flowing along the Mukerian side was concentrated on the Pathankot side.

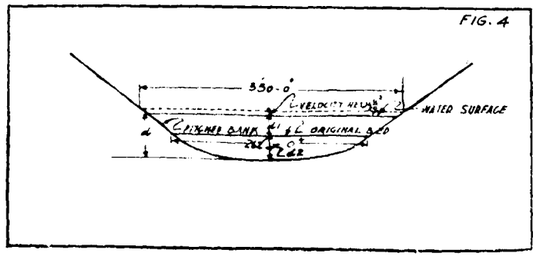
Due to the heavy armour provided on Pathankot side upstream by the Irrigation Branch, the main current of the Chakki flows along this edge and is not directed centrally vide Plate I. The Main current flows at the entrance to the gorge and strikes fiercely against the Mukerian bank. From here it is deflected to the Pathankot side, the sinuosity causing deep scour.

The second flood occurred on the 22nd August and rose to 1068 and was thus fiercer than the 1st one. This washed away fifty more blocks, i.e., about half the number washed away previously. The tremendous force of the current can be judged from the fact that such heavy blocks were carried to a distance of more than 2000 ft. 1 : 3 : 6 concrete blocks were, however, not damaged in this wiid action. The 1 : 4 : 8 blocks, however, suffered some abrasions and damage. The author believes that no more heavy stripping of apron blocks need be feared, as the channel has scoured out the bed by more than 5', and its transporting power has decreased due to the increase in its hydraulic mean depth. A reserve of wire trungars and houlders is, however, being maintained to meet any emergency that may arise in future. No serious floods occurred in 1952. In 1953 the floods again rose to 1951 level, but the works stood up to the wild torrent. After the floods, the author had an occcasion to inspect them and found that there was practically no change over the conditions observed by him in 1951. In 1954 also there were heavy floods but on a recent visit, the author did not see any heavy effect on the training works.

As a result of this interesting study of a turbulent hill stream, the author thinks that it would have perhaps been better to tie the blocks with steel rods to prevent their being washed away by the first few floods. These rods will no doubt rust and rot after some time, but by then, need for them may disappear through the increase in the hydraulic mean depth Another point to be noted is that deep blocks are liable to be more easily rolled due to heavy hydrostatic pressure against their faces. Blocks of large horizontal dimensions and less depth will therefore, be more suitable. In fact trungars full of stone are ideal provided they are strongly built and are well maintained.

At the instance of the Irrigation Branch model studies of the action of River Training Works were under-taken at the hydraulic Research Station, Malikpur. The model was run both under the original conditions and the new ones. It showed that the shooting flow through the lengthened gorge could not spread into the channel on Mukerian side but was mainly directed along the Pathankot Bank. This observation has been fully confirmed on the proto-type during the 1951 flood season. Obviously, it is desirable that the river should flow centrally attacking neither the Pathankot nor Mukerian Bank. A deflector built of trungars filled with stone was, therefore, proposed. A concrete block moulded to the shape of the deflector was used in the model at the down-stream side and its optimum position for directing the flow centrally determined. No work has, however, yet been under-taken on the construction of such a deflector.

FIG. 4



Inside the flume the banks are pitched and can not scour and it is only the bottom that will be scoured out. Actually this portion should assume the form of an arc of a circle. Lacey, however, assumed it to be an arc of an ellipse. For convenience, form of semi-ellipse will be assumed for the lower part.

Now inside the flume, the area of water section can be calculated in terms of total depth 'd'. Let it be denoted by A. The wetted perimeter can also be calculated in terms of 'd'. It may be denoted by 'P'. Then the hydraulic mean radius 'R' of the whole section A/P. Lacey's regime channel formula is not strictly applicable to such a channel, but its application will give results erring on the side of safety. Denote the velocity through the flume by 'U' then U = Q/A. Also according to Lacey for regime conditions $U = 1.17\sqrt{FR}$. Hence $Q/A = 1.17\sqrt{FR}$.

Therefore: $Q^2 = 1.17^2 A^2 FR = 1.369\, A^2 FR$.

From this equation the value of 'd' can be found by trial and error or by plotting a curve for Q against assumed valves of 'd'.

For Chakki Q = 120000 Cusecs.

$d_1 = 19.5$ ft. Assume $d_2 = 30$ ft.

Then $A = 301 \times 19.5 + \frac{26^2}{2} \times \overline{11} \times 30 \times \frac{1}{2} =$

$58695 + 6175.7 = 12045.2$

Wetted perimeter $= 88 + \frac{\overline{11}}{4}\left(\sqrt{(131^2+30^2)} \times 2 + 131 + 30\right)$

$= 363.83$

$R = \frac{12045.2}{363.83} = 33.10$

Then $120000^2 = 1.369 \times (12045.2)^2 \times F \times 33.1$

OR $120000 = \sqrt{1.369 \times F \times 33.1 \times 12045.2}$

$= \sqrt{1.369 \times 1.84 \times 33.1 \times 12045.2}$

$= 9.13 \times 12045.2 = 109973$ cusecs.

The agreement is close enough and 30 ft. depth of scour is the maximum that may be expected. Actually a silt factor of 1.84 is too low for a stream like Chakki with bed consisting of heavy houlders, but it was assumed purposely at this value to allow for local deep scour with a view to determining the safe depth of well foundations for abutments. The well foundations were taken 53 ft. below the bed to ensure their safety in the event of a damage to the training works.

It will be observed from the calculations given above that with the 30 ft. scour depth, the mean velocity will be about 10 ft. per second, which corresponds closely with its value in the unrestricted portions of the channel. During the floods, however, a surface velocity of 25 ft. per second corresponding to a mean velocity of about 21.25 ft. per second was observed, which would require an area of $\frac{120000}{21.25} = 5647$ sq. ft. only. The velocity being very high, the flood was passed with scouring of bed to a depth of 5 ft. The author does not think, the maximum scour in the artificial gorge will exceed 20 ft. at any time.

The width of apron was kept $1\frac{1}{2}$ times the scour depth or 45 ft. in conformity with Spring's rule for alluvial rivers, as shown in Plate. I. This rule is not applicable strictly to an armour of heavy concrete blocks.

At the mole head, upstream the width of apron was made twice the scour depth or 60 ft.

CANADIAN LOCOMOTIVES FOR INDIA—COLOMBO PLAN AID

Canada is making a gift to India under the 'Colombo Plan' of 120 of the new "W. P." Broad Gauge streamlined Locomotives built to the latest Indian design and specifications and used for hauling fast Mail and Express trains. They are also used for hauling passenger trains.

30 of these W.P. Locomotives will be arriving at Bombay Port and of these 27 have been allotted to the Central Railway. 3 Consignments of 2 locos each have already arrived in a knocked down condition. These consignments, on arrival, are taken to this Railway's Loco Workshops at Parel for assembling. The first 2 locos, after erection in Parel Workshops, have been put into service on the Jhansi Division of this Railway. The next four locos (of which 2 are under erection, and 2 are in the Docks) will be homed at Kazipet Loco Shed on the Secunderabad Division.

A gift of 56 locomotive boilers from Canada, also under the 'Colombo Plan', has already been received in India. The Central Railway's allotment of these boilers is two.

MAXIMA & MINIMA OF STOCK

By A. Deb, B.E.

IN any manufacturing industry, construction project or repair and maintenance workshops, the function of arranging raw, semi-finished, and finished materials vests in an independent unit, commonly known as Stores Department. The user or consumer, which according to terminology of the stores department should be the indentor for the material, indents certain materials for direct delivery to him and for which he accepts the debit against his works budget. There are, however, items of stores, which are to be held in "stock" for drawal by indentors against their requisitions. These items comprise of stores, which are commonly used by various indentors and for which there is a regular turn-over. This "stock" is held by the stores department as the indentor does not know well in advance, as to the allocation against which such stock would be utilised, though, from experience, he can forecast the necessity of having such "stock" to prevent any hold-up of work. The "stocks" are therefore, to be held against a Suspence Head of Accounts, which is released, as and when stores are drawn against respective allocation of work concerned.

The control of such stock by the stores department calls for certain maxims to be rigidly followed, as investment of capital is involved, in the purchase of stores. While holding a very small quantity in stock may give rise to a feeling of complacency, that much of the capital is not at charge, it may cause hold-up of work. Moreover, repeated procurement of small quantity, frequently, involves more clerical work, apart from cost of packing and freight. On the other hand, procurement of huge stock, involves larger capital out-lay with greater dividend, depreciation and obsolescence charges, larger storage accommodation and consequent expenses, increased maintenance cost. The limits for procurements must therefore be fixed after consideration of various factors, to prevent accumulation of surplus stores or creat a shortage of stores. These limits are called minimum and maximum.

Minimum stock represents expected consumption for the period of procurement. When therefore the stock reaches the minimum level, procurement arrangement for fresh stock must be made, so that by the time, the minimum stock deplets to nil, fresh stock might arrive. Minimum is therefore called stock-order-point indicating the point for ordering of fresh stock. The minimum stock will vary with different sources of supply—whether manufactured in own workshop, whether purchased as indigenous product, or whether imported from abroad. Other factors which need consideration are :—(1) Distance from source of supply (ii) Economic condition of the country (iii) whether the item is required for stocking to meet emergencies (iv) whether the demand for the item is erratic.

Maximum denotes the largest quantity of the item that the depot is permitted to hold and over which stock should not normally be held. Holding of maximum stock has some bearing with the issue of stores and it has been laid down in the State Railway Code for the Stores Department (1938 edition) that it should be the policy to keep the store balance within 40% of the year's issue. Maximum limit has no relation with minimum limit. These limits are quite independent of each other and are reviewed whenever the consumption varies. It is the experience that only guides the decision for fixing up the limit. Past consumption, unless considered in proper perspective may not be helpful. While considering the past consumption, the following factors should be kept in view :

(i) Consumption against capital programme or programmes for which separate budget provision is made.

(ii) Consumption against non-recurring revenue demand such as arrangement for fair, exhibition, popular celebration.

(iii) Consumption as substitute issues, in the absence of the proper item.

(iv) Issue of stores to other depot on transfer account, is to be off-set against consumption.

(v) Return of stores by indentor is to be off-set against the consumption.

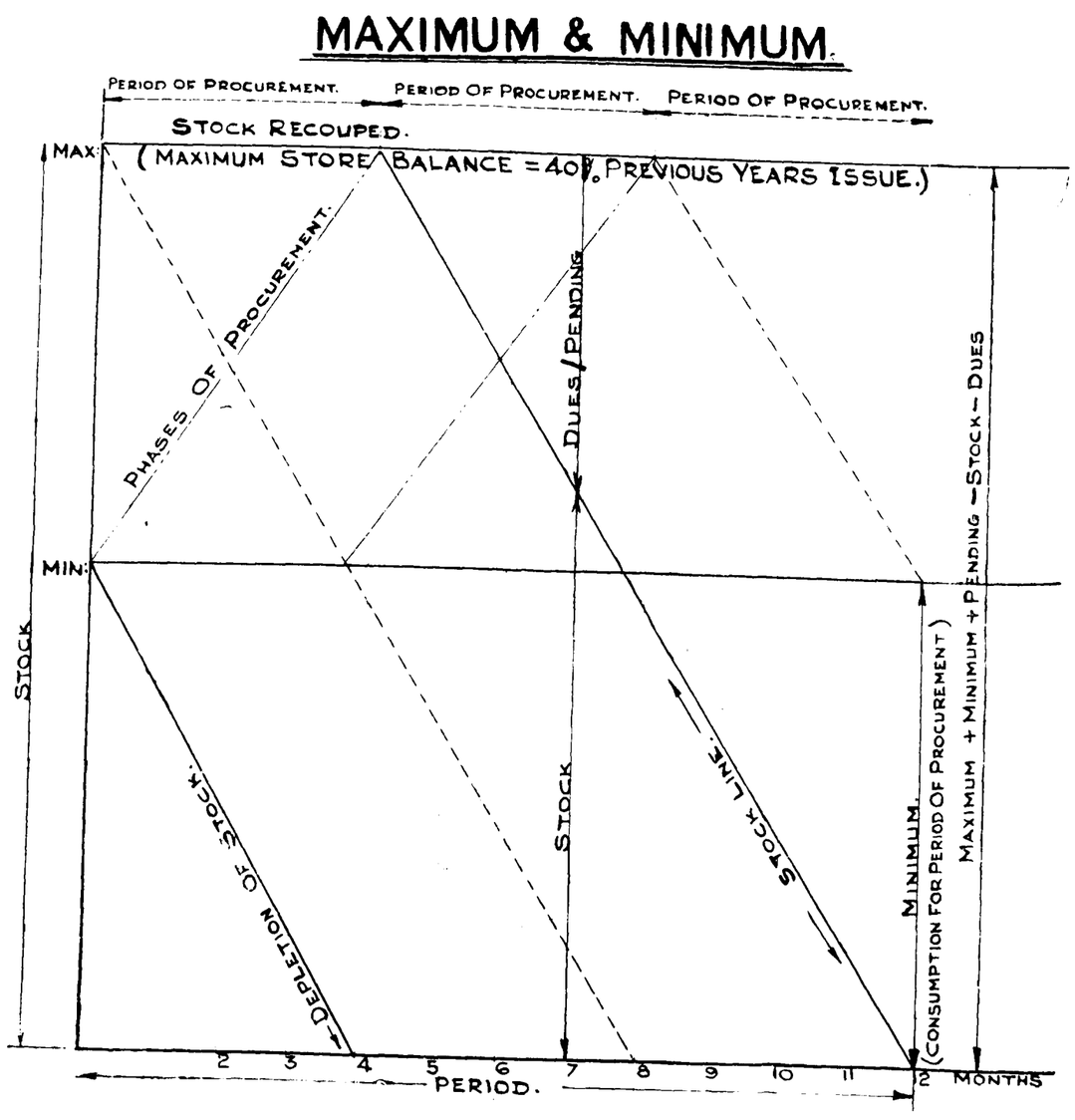
(vi) Issues for 'finishing' 'reconditioning' or 'repairing and return back' are not real consumption. Similarly, issues on loan or issue as sample are not real consumption.

For a correct assessment of past consumption, the period for which the consumption would relate has to be carefully selected. Seasonal issues, erratic issues, interval of issues are to be considered.

After determining the past consumption, the "Maximum" stock that should be ordered at a time should be fixed up, keeping in view the period required for procurement. Period of procurement may be assessed as under :

(i) Cottage or indigenous products 12–14 weeks.
(ii) Manufactured in railway workshop 16–20 ,,
(iii) Imported articles, purchased in India 16–20 ,,
(iv) Imported articles from abroad 32–48 ,,

This is a conservative estimate, for, imported articles sometimes require one year or more for procurement.



However, the maxim that "Recouping one maximum quantity when stock reaches minimum level" is always followed. This is also answer to the query when to recoup and how much to recoup.

The quantity that is ordered at any time is governed by the formula :

Quantity to be recouped = maximum + minimum + pending demands — dues on order — stock in hand.

If everything is in ideal state, then, stock at hand will be equivalent to minimum and that dues on order will fully satisfy the pending demands and quantity to be recouped = Maximum. Recoupment is made at intervals, equivalent to the period of procurement.

Maximum and Minimum has been shown in graphical form in the enclosed chart.

Many items of stores are procured through the agency of the Supply Directorate. They enter into contract for Supply of material, usually at fixed unit rate (Rate Contract), irrespective of quantity, for the currency of the contract period. Sometimes, similar contracts are executed by the purchase department also. To estimate for the quantity to be recouped during the contract period, (usually one year) the past consumption for equivalent period is to be taken into account. As fresh contracts are usually entered into, prior to the beginning of the contract period, provision has also to be made to meet demands for this intervening period of date of making the contract and date of operating the contract. Besides this, to safe-guard against complete depletion of stock at the end of any contract period, one 'minimum' quantity should be added to determine the quantity to be submitted for inclusion in the contract. The formula for recoupment holds good in such cases, on principle, with the deviation that the maximum in this case is the quantity to cover the contract period. Dues and pendings are duly considered, as in the general case, for estimating the quantity for the contract period.

Emergency stores, as the name implies are kept in stock, to meet emergencies, arising out of unanticipated break-down or deterioration, in spite of the fact that there is no regular turn-over for such stores to justify their inclusion against 'stock' items. Various users submit their requirement to stores department regarding the items and quantity of each item, to be held as emergency stores. Non-availability of the material, readily on demand, is one of the main criterion which guides the compilation of the list of emergency stores. The principle of maxima and minima does not apply in the case of emergency stores mainly because there is no regular turn-over for emergency stores. The quantity to be held is a pre-determined figure and replenishment is made as and when stocks are depleted, only to make up the depletion.

Steel is a "controlled" item. Rolling programme for steel is made quarterly. Indent for steel is also based on quarterly consumption and the indent for a period is placed five period in advance of the period, for which the supply is meant. The 'maximum' in the case of steel is therefore consumption for one period (three months).

104-MILE RAIL LINE IN RAJASTHAN

Preliminary engineering and traffic surveys for a Broad Gauge or a Metre gauge line between Chitorgarh and Kotah on the Western Railway, in Rajasthan, have been sanctioned by the Railway Board.

This rail link of about 104 miles would, when completed, provide the shortest rail connection between the Kotah and Udaipur Divisions of Rajasthan State. Besides improving traffic facilities for the general public, the new line is expected to help in the development of trade, commerce and industry in the region.

The surveys which will be carried out by the Western Railway are estimated to cost over Rs. 2,00,000.

HEAVY INSULATED REFRIGERATOR VANS

(From our special correspondent)

SCANDIA A/S, Randers, Denmark, founded in 1861, builders of railway carriages and wagons, have during the past 90 years been manufacturing railway carriages and wagons of various types.

One of the most modern wagons is a new type of welded all-steel refrigerator van, built in accordance with the UIC-specifications (International Railway Union) and especially intended for export from Denmark to the southern European countries of frozen and cooled fish, meat and vegetables.

These wagons are especially built for use in fast goods-trains and in passenger-trains with a maximum speed of 75 miles per hour.

The wagons are heavily insulated, and SCANDIA has built 90 wagons of this type for the Danish State Railways.

Denmark is a typical insular country surrounded by sea on all sides, and fishing has therefore always been one of the marked trades in this country. For that reason it comes natural that there is exported fish in great quantities from Denmark to southern Europe, in which districts it is difficult to procure fresh fish.

For the rest Denmark is a distinct agricultural country with among other things a methodical worked cattle breeding, and fresh meat is therefore also a great commodity.

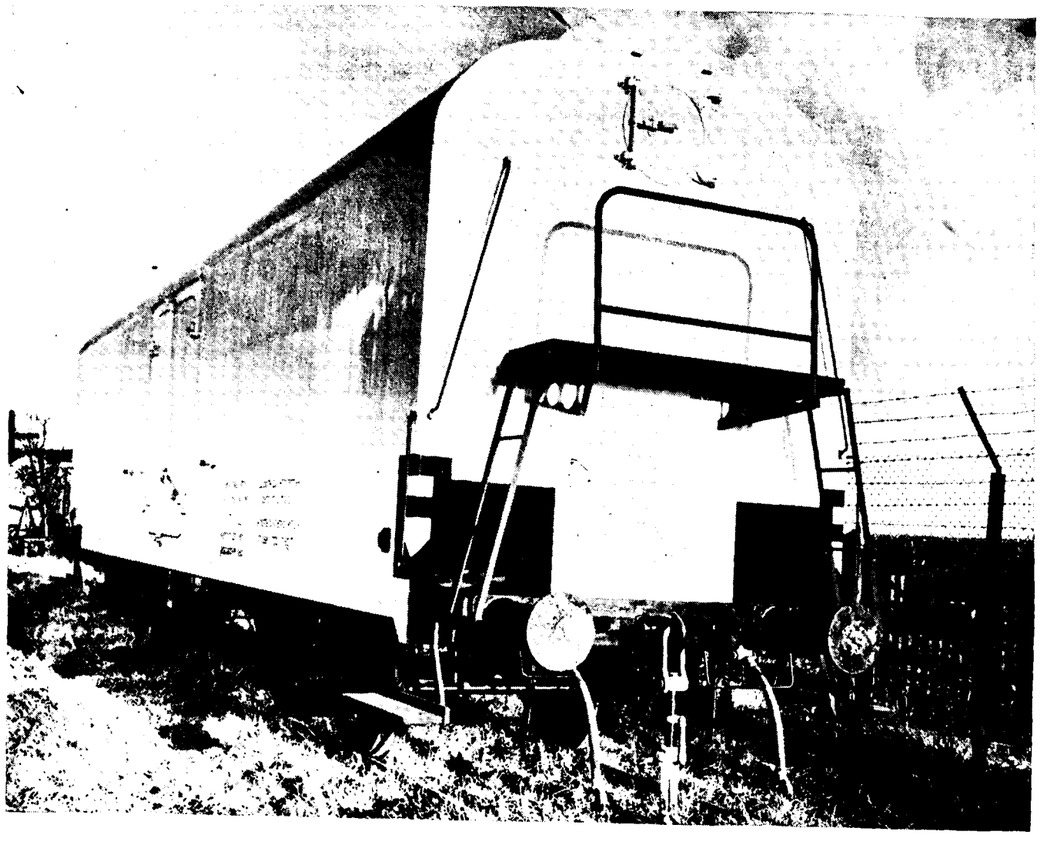


Fig. 1

Danish State Railways have for that reason decided to render farming and fishing a service as good as possible by having built these 90 new refrigerator vans which will possibly be followed by more, and there is further the advantage by procuring such heavily insulated cars that they can be used on the way back to Denmark for the transport of southern fruit rich in vitamins for the Danish market so that there is established an interaction on behalf of the railways and the countries they attend.

The photo (fig. 1) shows the all-steel refrigerator van made for the Danish State Railways with the following data:

Capacity: 38.500 lbs., 1430 cub. ft.
Tare weight: 35.000 lbs. including 5.500 lbs. ice.
Length over buffers: 38′ 5″
252 meat hooks.
Distance between axles: 21′ 8″.
Refrigerant: Water-ice or Solid Carbon Dioxide.

Before the actual manufacture was started a van used for thoroughgoing experiments was built. The Danish and the Italian State Railways have for that reason carried out comprehensive transmission experiments.

On the basis of the experiments which were achieved with the first van various improvements were made on the subsequent vans, while at the same time the weight was reduced in accordance with the international claims.

The vans are built according to a proposal stated by the Food Transport Council established by the Academy for the Technical Sciences, in which council the various ministries and the people taking an interest in these transport problems are represented. Furthermore the vans are built in conformity with the claims which the International Railway Union makes to the standard refrigerator vans, and according to the judgment of the council these types of vans should be most suitable for inland transport as well as transport from Denmark to the southern countries of both cooled and frozen commodities.

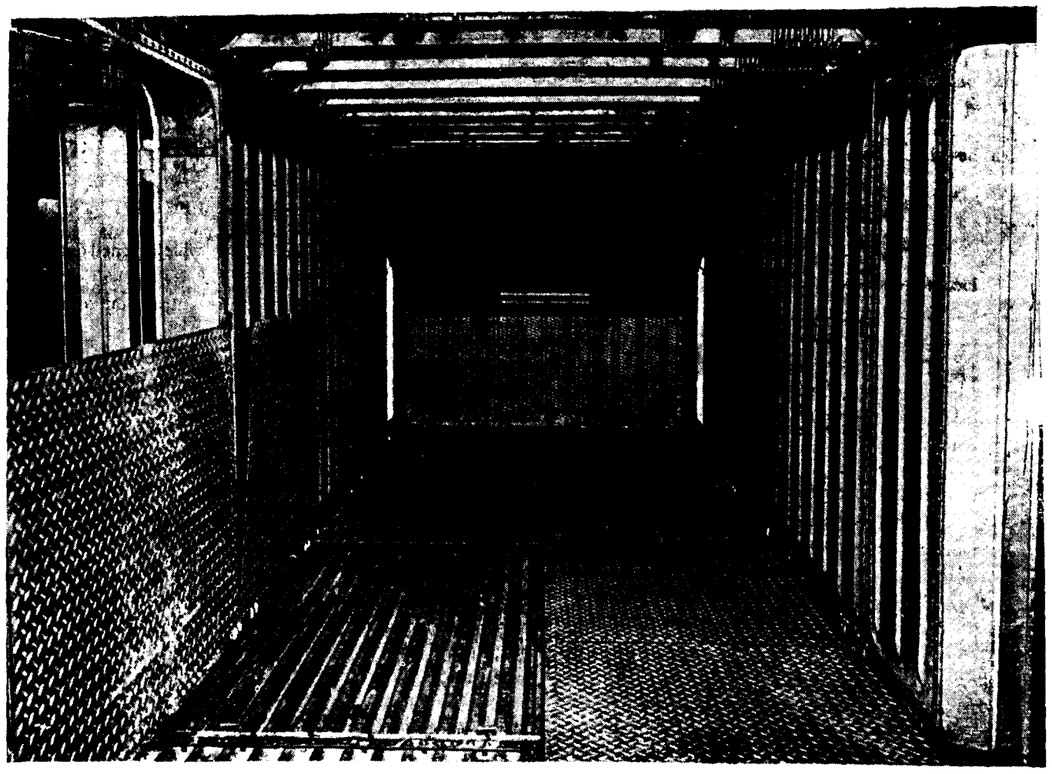


Fig. 2

According to the council's proposal the van has been constructed for a heat transmission coefficient o 0.08193 BTU/sq. ft. °Fh, whereas the International Railway Union allowed a coefficient of 0.10241 BTU/sq. ft. °Fh for a similar standard refrigerator van.

The inside lining is made of galvanized steel sheets in order to make a thorough cleaning as well as removal of any bad smell from fish transport and the like possible, before the van is going to be used for other commodities which might be damaged by the smell. It has been our endeavours to make the construction of the van as tight as in any way possible by using strong rubber tighting stripes at the doors devices in order to prevent the outside air from intrusion through outlets of the ice-boxes, and thus the 10 rotors placed on the roof serve to circulate the air in the van, whereas the admission of the air from outside does not take place.

The rotors absorb the air from the van and blow it down through the ice-boxes, from where the cooled air streams into the van, partly through the space between the floor of corrugated sheets and the chequer plates above, some of which have drilled holes. In each end of the van an ice-box is placed, the partition wall of which is adjustable so that each box holds a maximum weight of 2.750 lbs. of ice. The partition can be placed close against the inside end of the van. Thus there will be an increased space of floor to be used for commodities requiring no ice-cooling.

The way in which the partition is constructed allows it to be turned round and kept in this position during the cleaning of the ice-box (Fig. 2).

The ice-boxes are filled from an outside platform at each end of the van through a circular filling opening with a conical cover.

Inside the filling opening there is in each end of the van room for packages of 650 lbs. of carbonic acid ice.

From one of the platforms the screw brake of the van is also worked, and it is connected with the braking applicance for the air-brake of system "Hildebrand–Knorr Hikp" with SAB brake-block slack adjuster.

Furthermore the vans are equipped with SAB brake governor rendering the normal manual settling of the brake "empty" or "loaded" unnecessary as the braking varies automatically according to the size of the cargo.

Between the outside and inside sheeting of the van the insulation consisting of ISOFLEX is placed. In one of the vans, however, experiments are made with IPORKA as insulation material. Both the sheetings are made absolutely tight in order to prevent invading water from damaging the insulation material and thus reducing the heat insulating power.

PRODUCTION OF LOCOMOTIVES—CHITTARANJAN SETS UP RECORD

A new production record has been set up by the Chittaranjan Locomotive Works, which turned out 11 locomotives each during July and August this year.

The production of boilers has also attained a new record, with nine complete boilers turned out during each of the last two months.

The original production target of 120 W. G. locomotives was achieved long time ahead of schedule in May, 1954. The outturn has increased from six locomotives per month in the early part of 1954 to eight locomotives per month towards the end of that year, 10 per month from January to June this year and 11 per month at present. The present rate of 11 W. G. locomotives per month is equivalent to the production of 165 average-sized locomotives. Till the end of the first week of September, Chittaranjan has turned out a total of 275 locomotives.

With the increase in production the cost per locomotive had come down from Rs. 7.5 lakhs per locomotive in the beginning to less than Rs. 5 lakhs at present. As against this, the cost of an imported engine of the same type, as manufactured by Chittaranjan, is about Rs. 5.39 lakhs.

The Railway Board has approved a new target of 200 locomotives plus 100 spare boilers per year and the details of the scheme are at present being worked out.

Out of 5,335 components, which go to make a Chittaranjan locomotive, only 90 items are at present being imported. Another 769 items are purchased from sources within the country, while all the remaining 4,476 items are manufactured at the Chittaranjan Locomotive Works. The imported items need specialised machinery for mass production and their manufacture at Chittaranjan is not considered to be good business.

There are about a dozen foreign experts, brought under the Colombo Plan, working at Chittaranjan. Their expert assistance is necessary in demonstrating the working of certain modern machines.

Diesel Electric Locomotives for Steel Works

IN addition to the seven 0–4–0 locomotives of 300 H.P., Steel Company of Wales require Bo-Bo type locomotives of opproximately 500 H.P., weighing about 70 tons. To meet this requirement Brush Bagnall Traction of Loughborough have designed a Bo-Bo locomotive fitted with a Mirrlees J6 engine. The electrical equipment is manufactured by the Brush Electrical Engineering Co. Ltd. and the mechanical part are supplied by Messrs. W.G. Bagnall Ltd. of Stafford. The erection of the complete locomotive is carried out in the Brush Bagnall Traction Erecting Shop at Loughborough.

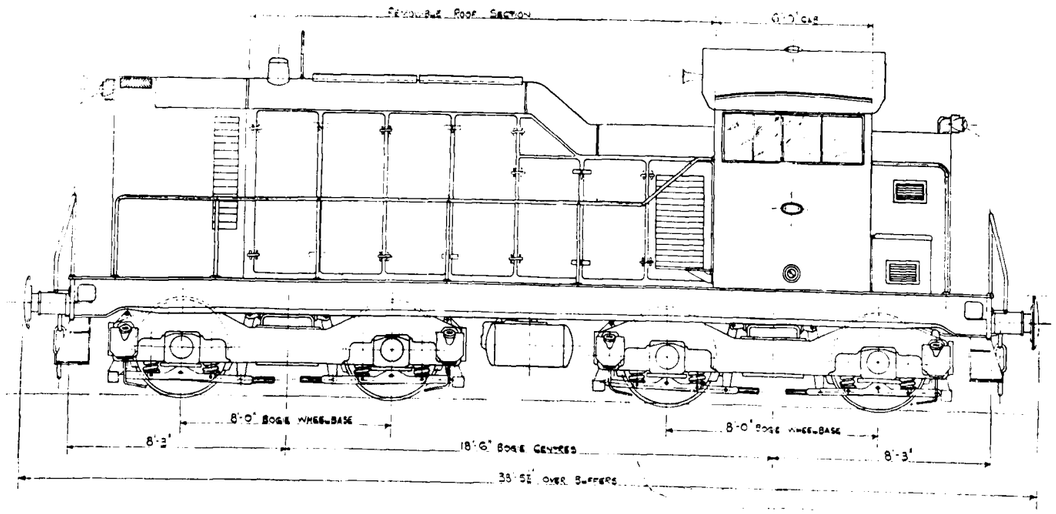
The locomotives have been specially developed in conjunction with the Steel Company's engineers to suit their requirements. They are of extremely robust construction and special attention has once again been paid to visibility from the cab. The power unit consists of a Mirrlees 6 cylinder normally aspirated diesel engine developing 515 H.P. at 875 R.P.M. coupled to a Brush self ventilated compound wound main generator. A self ventilated shunt wound auxiliary generator is flange mounted to the main generator. All axles are driven by axle hung, nose suspended force ventilated double reduction geared traction motors. These are series wound machine operated in series parallel across the main generator output.

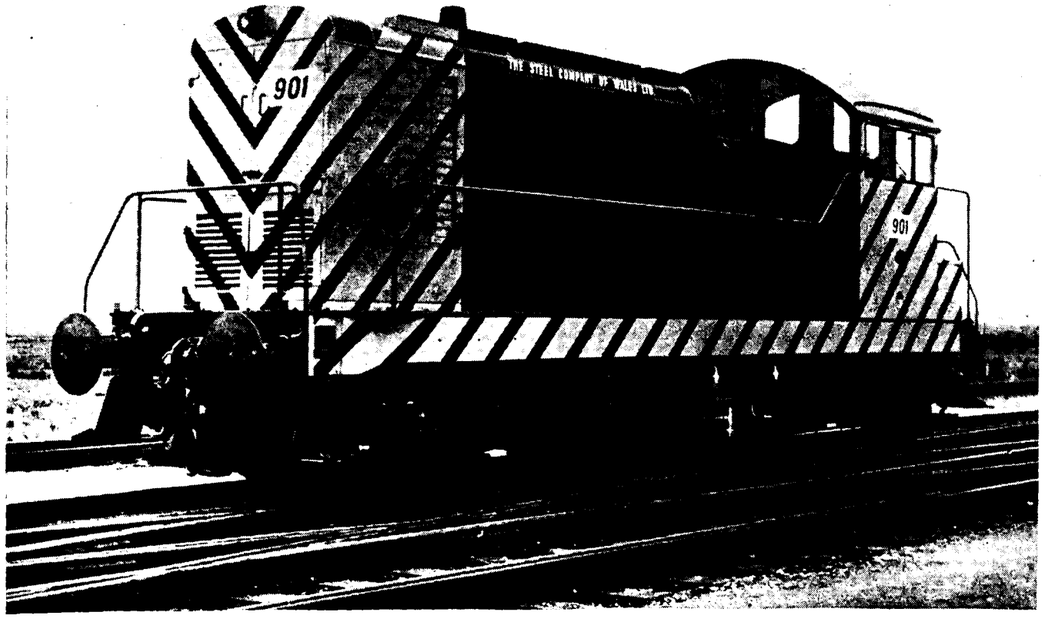
Principal Dimensions

Gauge	4–8½"
Length over buffer beams	35′ – 0″
Bogie wheel base	8′ – 0″
Distance between bogie centres	18′ – 6″
Wheel diameter	3′ – 6″
Weight in working order	70 tons
Starting tractive effort at 25% adhesion	39,200 lbs.
Maximum speed	28 m.p.h.
Minimum radius of curve	80′ – 0″

The underframe is of all welded construction built from steel plates. The platform plate is 1″ thick and is continued over the length and breadth of the locomotive. Vertical beams are formed on the centre line and on the outer edges of the deck plate by the attachment of steel plates with heavy flanges. Cross members are provided of similar construction and the whole frame is so designed that lifting brackets provided on the buffer beams are capable of lifting the locomotive complete with both bogies attached. No special jacking points are provided as the locomotive can be jacked anywhere along its outside frames or at the buffer beams.

Four wheeled bogies are of all welded construction, the side frames are made from 2½" thick slab and the centre transom and headstocks are fabricated from steel plates. The main frames lie on the centre of the spring suspension and springs which are of the coil type are located in housings of cast steel which are welded integraliy into the main frame. The roller bearing axleboxes consist of single bearings which are double row self aligning manufactured by Messrs. Skefko. The suspension therefore is ideally arranged in an underslung





Close-up view of the Brush-Bagnall 515 H. P. Bo. Bo. Locomotive.

(Photograph by courtesy of Brush-Bagnall)

manner by the provision of double spring beams. Both axleboxes and guides are provided with renewable manganese steel liners.

The bogie centres which are bolter to the underframe and to the bogies are steel castings, a spherical male bearing being provided on the underframe and the housing to take this on the bogie is lined with Mintex.

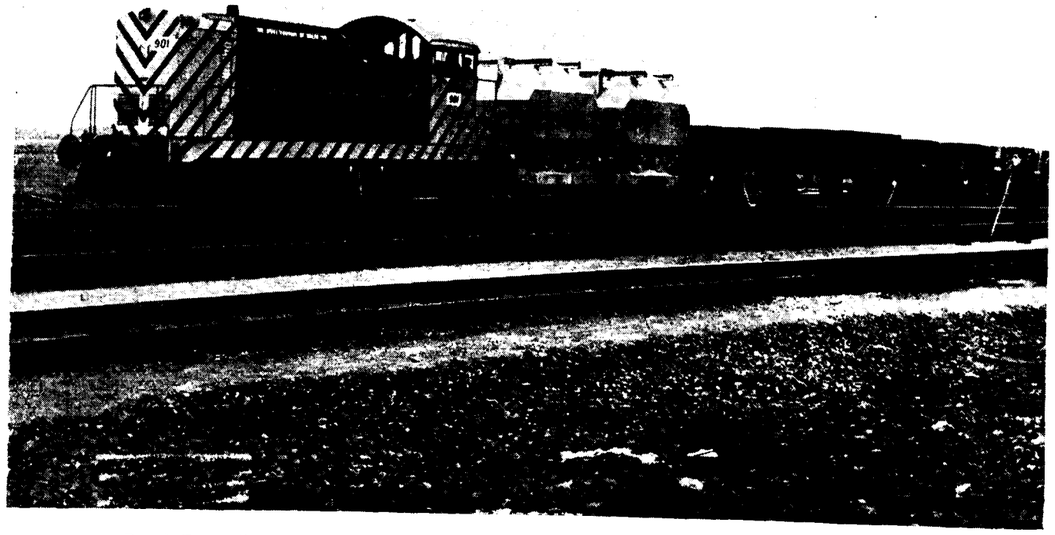
The wheels are built up from rolled steel centres on which tyres are shrunk. The axles which are made of steel BS24/2 provide plain bearings between the wheels for the traction motor suspension.

Clasp brakes are provided on all the wheels. Brake cylinders are double acting and are so arranged on the bogies that they are in line with the brake block application, no offset levers are therefore necessary. A handbrake is provided on one pair of wheels.

The engine housing has been carefully designed to provide the maximum cross visibility from the cab and to achieve this the housing is swept down over the generator compartment. A walkway of embossed chequer plate is provided all round the housing and safety handrails are fitted.

Footsteps are of the open flow tread type fixed to each corner of the locomotive. They are designed so that a shunter can stand within the loading gauge.

A separate radiator compartment is provided which houses the radiator panel. The fan runner and bearing housing is carried on a partition plate between engine and radiator compartment. The radiator header tank is integral with a roof section and the water level indicator is provided which is visible outside the locomotive. Air is drawn in through adjustables side louvres which are hinged to obtain access to the rear of the panel and pipe connections and the air is then discharged through the



Brush-Bagnall 515 H. P. Bo. Bo. Locomotive supplied to The Steel Company of Wales Ltd.

(Photograph by courtesy of Brush-Bagnall)

roof. Access to the radiator elements is provided through two doors on the front of the locomotive. A by pass thermostat is fitted in the cooling water circuit for rapid warming up of the engine. The engine compartment has full length hinged lift off doors on each side and roof access is provided directly above the cylinders heads. Filtered air is blown into the engine compartment by the main generator fan. The generator compartment is sealed from the engine room by a partition and full length doors are fitted on each side so as to provide access to the generator commutator covers. All air to the generator is drawn through Visco oil wetted filters fitted on the hinged doors on the generator compartment.

The cab is of ample proportion and is designed to give maximum visibility in all directions. It is timber lined up to the waist rail and the beech floor incorporates two trap doors for access to the fuel tank, piping and electric wiring. Two doors are provided on opposite corners which give access to the walkways at the front and rear of the locomotive. A fluted aluminium kicking panel is provided around the cab sides which is removable to provide access to sanding check valves and cab heater pipes. The drivers seat is both tip up and swivel and is adjustable in height. A back rest is provided. A second seat forms a compartment which houses part of the radio equipment and stows the two arm rests which can be fitted over the sliding windows when these are in the open position.

Lighting is by two electric lamps in the roof of the cab. Air operated windscreen wipers are fitted to both front and rear driving windows.

(Continued on page 39)

The Production of Continuous Rail-lengths by Flash Butt welding

Some Applications of A.I. Equipment by British Railways (S.R.) and London Transport

(From a Special Correspondent)

IN various systems throughout the world, increasing use is being made of track incorporating long, continuous lengths of rail, produced by welding together the shorter standard lengths. In this country, standard 60-ft. lengths have been welded together to produce continuous lengths of 180 ft., 240 ft., and 300 ft., according to requirements. It is understood, however, that consideration is now being given to the welding of lengths up to 1000 ft.

Experience has shown that properly-constructed permanent way of this type, with suitable joints between the continuous lengths, is not, as might be supposed, prone to thermal distortion problems. On the other hand, it affords a number of advantages, among which may be mentioned reduced track-maintenance, reduced tyre-wear on rolling stock, and improved passenger-comfort on account of quieter, and generally smoother running. It is also advantageous for conductor-rails in electrified systems, since it reduces arcing, and the consequent burning of whatever moving-contact device is employed.

One of the most effective and economical methods of joining the standard rail-lengths is flash butt welding. This process is employed at the Redbridge rail-welding depot of British Railways, Southern Region, and at the Lillie Bridge, London, depot of the L.T.E. system. At both these works, extensive use is made of equipment which was supplied by A. I. Electric Welding Machines, Ltd., 68 Victoria Street, London, S.W.1. At the Redbridge depot, various rail-sections up to 14.7 sq. in. are handled, including both running and conductor-rails, and of the latter, continuous lengths up to 300 ft. are produced. Running-rail, of 98 and 109 lb. per yard weight, is built-up into continuous lengths from shorter standard lengths ranging from 15 ft. 1 in. to 45 ft.

(Continued from page 38)

A cab recirculatory heater is installed of Clayton Dewandre manufacture which takes engine cooling water through its heating elements. An electric fan provides the air circulation.

The fuel tank is situated under the cab floor and has a capacity of 350 gallons. Level gauges are fitted on each side of the tank adjacent to the filling connections.

Beneath the radiator compartment and in a housing on the back of the cab are the traction motor blowers. The housing on the back of the cab also contains the engine starting batteries. Doors are provided for topping up and the cover is detachable for easy removal of the batteries by overhead cranes.

Each of the traction motor blowers consists of a Sturtevant centrifugal fan coupled to a Brush motor. Filtered air is drawn in through Visco oil wetted filters located in the housing doors and air is blown through to the traction motors through steel trunking and flexible bellows.

Westinghouse straight air brake equipment is fitted and in addition an air supply is provided for the operation of air dump cars. An electrically driven compressor Westinghouse DHC2 type is located beneath the underframe between the bogies and air at 75 lbs./sq. in. is available at hose connections at the front and rear of the locomotive. In addition to the power brakes a hand brake is fitted which is operated by a vertical wheel situated in the driving cab. Pneumatic sanding is provided for forward and reverse operation. A warning horn of the pneumatic type is mounted on the cab.

The control gear is housed in a cubicle in the cab and is made dust-proof. Adequate inspection doors are fitted to the front, sides and top of the cubile and on the top is fitted a sloping instrument panel which contains all control and lighting switches. All driving controls mounted on the top of the cubicle together with the air brakes handle are duplicated on each side of the cubicle. Radio transmitting and receiving equipment is fitted and the loud speaker and controller is mounted in the centre of the cab front plate between the centre windows. A 12 volt battery is situated in a separate battery box fixed to the back of the cab. The charging dynamo is belt driven from the free end of the diesel engine.

Various combinations of the latter are employed according to requirements, so that cutting-off and wastage are minimized.

The standard lengths are stacked in an extensive storage area, served by a large gantry, which is employed to lift successive lengths on to a set of roller supports. In preparation for welding, the ends to be joined are lightly ground, in order to ensure good electrical contact in the welding machine, and for this purpose, portable pneumatic tools are employed. If necessary, the ends are also trued by setting on a 90-ton hydraulic press.

The prepared lengths are fed endwise on the roller supports, into the right-hand side of the A.I. type APF/40 rail flash butt welder shown in Fig. 1. A close-up view of the working zone of this machine, which has a capacity for welding running-rail sections up to 131 lb. per yd., and conductor-rail sections up to 150 lb. per yd., is given in Fig. 2. Hydraulically-operated, it can apply an upset pressure of 40 tons, and an important feature is the fully-automatic control of the welding cycle, including preheating. The left-hand head is fixed, and pre-heating is effected by a reciprocating movement of the right-hand head. The number of pre-heating strokes is not pre-set, and reciprocation continues only for as long

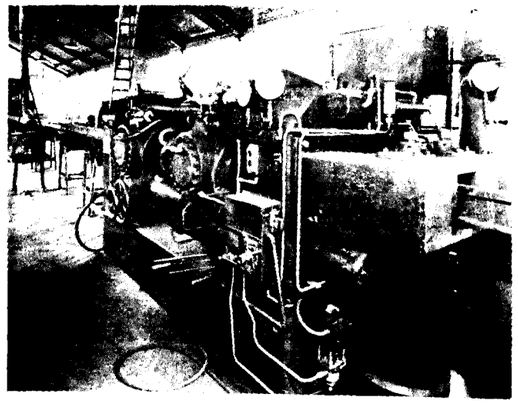


Fig. 1. The A. I. Type APF/40 Flash Butt Welder, here shown, will handle Rails up to 13 sq. in. section.

as is necessary to heat the work uniformly to the required temperature. Once this condition is reached, the flashing and upsetting stages of the cycle are initiated

automatically, and it is thus ensured that welds of consistently high quality are obtained.

On the entry side of the machine, adjustable guide-rollers engage the sides of the rail-section web, so that it is fed-in centrally, and another adjustable roller supports it at the appropriate height. The two lengths of rail are centralized in the gap between the separate conductor—and holding-clamps, and the latter are engaged by operating the appropriate control valves. Provision is made, in the left-hand head, for aligning the sections vertically and horizontally, by means of two handwheels, which are seen in use in Fig. 2. These adjustments,

Fig. 2. Close-up of the Working Zone of the Machine shown in Fig. 1. The Weld Cycle, including Preheating and Forging, is fully automatic.

it may be noted, are made after the clamps have been applied, and it is thus ensured that any movement of the work, caused by closure of the clamps, does not influence the setting. Once the work has been clamped and aligned in this manner, the automatic cycle is initiated by pressing a button.

The motion of the right-hand head, for forging the weld after the flashing current has been cut off, is provided by two hydraulic cylinders connected directly to it. These cylinders, and their connections, are so disposed as to ensure that the forging load is applied along the centre-line of the rail, so that the forging pressure is uniformly distributed throughout the section. The hydraulic supply to the cylinders is provided by an air/hydraulic accumulator, so that the necessary rapid forging action, following immediately after the flashing-current cut-off, is obtained. This accumulator operates in conjunction with a Mono-Radial hydraulic pump, driven by a 7.5-h.p. motor, and the pump also supplies a second accumulator, incorporated in the clamping circuit. Compressed air for both accumulators is drawn from a receiver, coupled to an external supply through a reducing-valve. By suitable adjustments of the reducing valve, the air-pressure in the receiver, and consequently the loads actually applied, may be varied to suit the work.

The single-phase, 350-kVA. welding transformer is water-cooled, and the secondary current-path is designed to provide equal current-distribution to the upper and lower electrode clamps, and thus ensure uniform heating. Control of the heating current is afforded by a tapping panel, which gives a range of secondary voltages from 3.7 to 8.3, in 14 steps. Various safety interlocking devices are incorporated, and the welding current cannot be applied unless the electrodes are in contact with the work, and is cut off automatically if they are retracted during the working cycle.

The duration of the complete welding cycle varies according to the section-weight of the work and for a rail of 109 lb. per yd., is approximately 3 min. Upon completion of the weld, the clamps are released, and the rail is moved longitudinally to bring the joint into position in the resistance heating machine seen in Fig. 3.

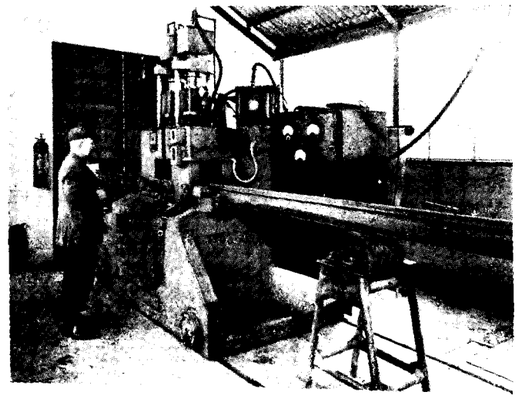


Fig. 3. A.I. Resistance Heating Machine, for normalizing the welds. The electrode clamps are pneumatically operated.

This equipment, also supplied by A.I. Electric Welding Machines, Ltd., is employed for annealing the welds, as the welding operation results in a local increase in hardness. The machine has a sturdy fabricated base,

upon which are mounted two vertical, pneumatically-operated clamping heads, each incorporating a pair of water-cooled copper electrodes. These electrodes are applied to the work at a predetermined distance on either side of the weld, and the heating gap between them is adjustable from 4 in. to 12 in.

The clamps are controlled by valves mounted on the front of the machine, and each applies a pressure of 10 tons. In order to ensure uniform contact with the rail, the electrodes are self-aligning, and each head also incorporates a compensating device such that the work is free to expand longitudinally during heating. Current is supplied separately to the upper and lower electrodes by two 120-kVA. Single-phase water-cooled transformers, and for each transformer seven different secondary voltage settings can be obtained. This arrangement permits accurate control over the heat-distribution, so that the latter may be kept uniform over the full cross-section.

Once the electrode-clamps have been applied, and the corresponding push-button control operated, the heating cycle proceeds automatically, under the control of two Pyrostat receivers. One of the latter is arranged to respond to the temperature of the head of the rail, and the other to that of the base. The Pyrostat are adjustable, and are pre-set to operate when the required temperature of 850° C. is reached. Each controls a contactor associated with the corresponding transformer, so that if one portion of the rail reaches the required temperature first, the supply to that portion is automatically cut off. In this way, local overheating of one portion, before the required temperature is reached elsewhere, is avoided. In practice, and independent check is maintained by the use of temperature-responsive Tempilstik crayons (J. & M. Steel, Ltd.), marks from which change colour when predetermined temperatures are reached.

As may be observed from Fig. 3, the unit described is mounted on wheels, so that it can be moved along rails towards or away from the butt welder. This arrangement permits the simultaneous alignment of one joint in the welding machine, and that immediately preceding it in the normalizing machine, when circumstances favour such a procedure, for example, when welding together sections of uniform length. When irregular lengths are being joined, this procedure is not justified, because of the repeated re-positioning of the normalizing machine that would be necessary. The normalizing machine may also be positioned so that, when a joint is located in it, the next joint is clear of the delivery side of the welder. Immediately after welding, surplus upset material is removed from each joint by fettling it with portable pneumatic chipping-hammers, and this operation may conveniently be performed while the preceding joint is being normalized. The bogie of the annealing machine is provided with traversing gear, and a brake for locking it in position. The annealing treatment, it may be noted, is not applied to conductor rails, for which strength is not a primary consideration.

From the building accommodating the welding and normalizing the machines, the rails are fed, on the support-rollers, to another section, where the joints, when cool, are ground smooth with portable pneumatic tools. During this stage, care is taken to ensure that the top and sides of the joint are cleaned off flush, so that, on the top and running faces particularly, there is no irregularity. To ensure that the required standard is maintained, the surfaces are checked with a straightedge from time to time, as grinding proceeds.

The completed rail-lengths are levered off the support-rollers on to racks which incorporate steel skids, where they are temporarily stored. These racks are adjacent to a siding, and, when required, the rail-lengths are loaded on to a special train by lifting and traversing on an over-head gantry. On the train, they rest on bolsters, and are suitably secured with chains. A feature of interest in connection with the transport of the rails in this manner is that, once loaded, they are conveyed without difficulty along normal tracks. They flex sideways freely, accommodating themselves to any curve negotiated by the train, without exerting undue side-load.

In order to maintain a high standard of weld quality, tup tests are performed, on a special rig, on samples welded each morning and evening. The rig comprises a 1¼-ton tup, which can be raised to any height up to 30 ft., by means of a power-operated winch, and allowed to fall on to the specimen. The latter is supported at two points a predetermined distance apart, and symmetrically disposed, so that the tup strikes the top of the section on the centre-line of the weld. Various heights of fall and numbers of impacts are employed, according to the weight of the section.

These impacts result in considerable deformation of the specimen at the weld, which must not, however, show any sign of failure. In the event of a failure, all welds made since the last satisfactory specimen was checked, are also tested. Any necessary adjustments to the welding-machine settings are made in conjunction with tests on further specimens, and this procedure is also followed in setting-up the machine, when changing-over from one section to another.

THE LONDON TRANSPORT PLANT

The methods followed at the London Transport Lillie Bridge depot, earlier mentioned, are generally similar, except that mechanical handling aids are more extensively employed. Standard rail-lengths are delivered from a siding to the right of the main floor area of a long building which houses the rail welding shop, and are handled by a gantry of normal type. As they are unloaded, they are placed on racks, to the right of the

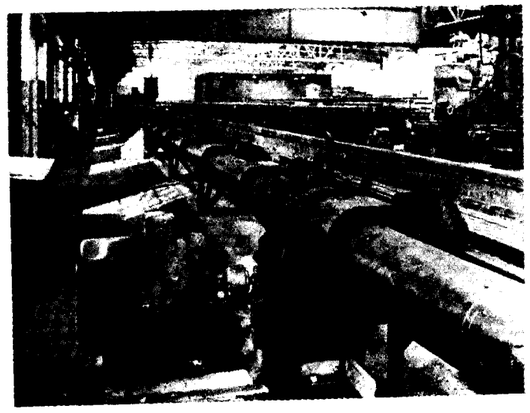


Fig. 4. At the Lillie Bridge Depot of London Transport, a power roller conveyor is employed to feed the rail lengths to the Flash Butt Welder and normalizing machine.

welding line, to which they are subsequently transferred the same gantry. In the welding line, they are supported on power-driven rollers, which feed them longitudinally to the successive line-station. A view of the roller-conveyor system is shown in Fig. 4.

At the first station in the line is installed the Clifton & Baird, Ltd., combined rail sawing and drilling machine shown in Fig. 5. This machine is employed for trimming the ends of the sections squarely to length, and, when dealing with sections which will form the ends of the major lengths, simultaneously drilling the holes. These holes are for the fishplate joints which connect the major length together, when the track is laid. The saw saddle, seen on the right in Fig. 5, mounts a 26-in. diameter segmental-tooth saw, and the hydraulic feed is variable up to 15 in. per min. Upon completion of a cut, the head rapidly withdraws. A vertical, a screw-operated vice is provided on each side of, and close to, the saw, so that the work is rigidly held. Hydraulically-operated rollers are raised to support the work during loading, and are lowered once it is in position, ready for clamping.

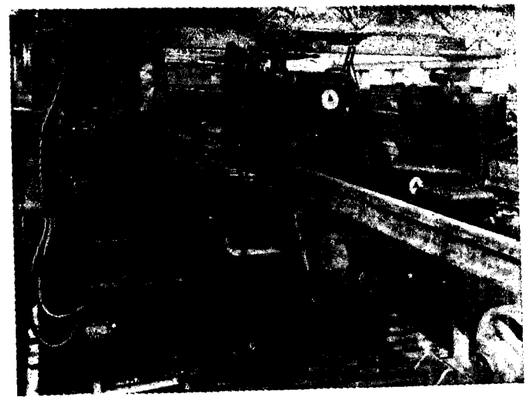


Fig. 5. This Clifton & Baird combined rail sawing and drilling machine cuts rail-sections squarely to length, and drills the fishplate bolt-holes.

Each of these rollers is provided with a handwheel, to facilitate loading, and setting the work longitudinally.

Each group of drilling spindles is incorporated in a separate head, and is adjustable vertically and horizontally, by screw-operated slides. These heads, also, have hydraulic feed, which is variable up to 15 in. per min. The spindle-speed is variable, by means of a gearbox and hand change lever, to give a cutting-speed of 50 ft. per min., for drills of ⅞ in., 1⅛ in., and 1⅜ in. diameter. Separate electric motors drive the drilling and sawing heads through multiple V belts, and peripheral saw-speeds of 20 ft., 30 ft., 40 ft. and 60 ft. per min. can be obtained.

From the sawing and drilling machine, the work is fed to the flash butt welder, which is seen in operation in Fig. 6. The machine is of the APF/40 type, already described, and in the illustration, the associated air/hydraulic equipment may be seen. The progress of the welding operation is observed from the small sheet-steel protective booth visible at the extreme left. Completed welds are fettled immediately they are moved of the machine, as already described.

The removal of upset materials from the weld by hand-operated chipping-hammers, is, it may be noted, likely to be superseded in the immediate future by a fully-automatic process. A. I. Electric Welding Machines, Ltd., in conjunction with London Transport Executive engineers, are developing a weld upset removal unit, into which the welded rail will be

Fig. 6. The A.I. Type APF/40 Flash Butt Welder in operation at the Lillie Bridge Plant. The arrangement of the associated air/hydraulic equipment is also seen.

traversed immediately after welding. This unit will remove the upset automatically, by mechanical means, within very close tolerances. These tolerances will be such that only very light subsequent grinding will be required on the head and running faces of the rail.

The A. I. weld annealing machine employed is of a somewhat different design from that earlier described, but is basically similar in function. Bogie mounted, it incorporates a pneumatically-operated clamping-head frame, which advances and withdraws the two vertically-disposed electrode clamping heads horizontally over the work. The lower electrodes are mounted rigidly in the frame, and the upper pair are independently operated through linkages, by separate pneumatic cylinders. A close-up view of the working zone of the machine, with a weld in process of being normalized, is shown in Fig. 7.

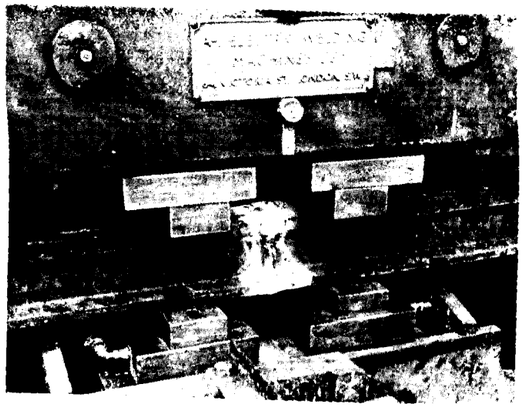


Fig. 7. Close-up view of the working zone of the A.I. normalizing machine at Lillie Bridge.

The head-retraction feature of the machine, in conjunction with a special roof-crane, facilitates the handling of the assembled rail-lengths. This crane is shown in use in Fig. 8, in which the normalizing machine is also seen. As may be observed, the crane comprises a long, girder-like structure, disposed parallel with the roller-conveyor line, and occupies most of the remaining length of the building, beyond the flash butt welding machine. Traversable across the width of the building, on rails incorporated in the roof-structure, it has seven synchronized hoists, equally spaced along is length.

Upon completion of normalizing on any given rail-length, the head of the normalizing machine is retracted,

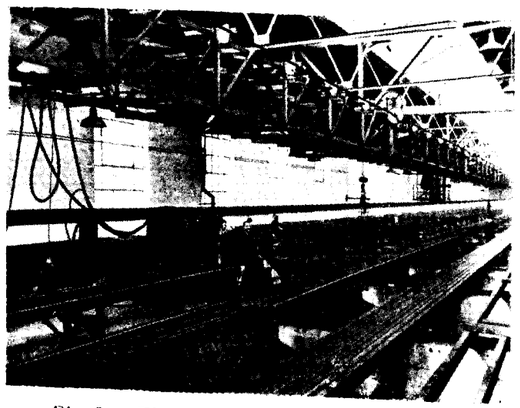


Fig. 8. The handling of completed rail lengths, up to 300 ft. long, is facilitated by this 7-point traverser crane.

leaving the work clear so that it can be lifted vertically off the roller track. The crane is employed to convey the rail to the racks seen at the right in Fig. 8, where the welds are allowed to cool, and they are then ground off smooth, as already described. The racks also serve for temporary storage, until a train-load of rail-lengths has accumulated. The special traverser crane is then used to transfer the load to a train on the siding at the right-hand side of the building, and in this way, rail-lengths up to 300 ft. are handled without difficulty.

TYPE APHF/30. R. WELDING MACHINE

The type APF/40 A. I. rail flash butt welder earlier described, has a maximum capacity of 131-lb. per yd. section-weight, corresponding to a section of approximately 13 sq. in. Rails of the weight, however, are no longer used in this country, and the present maximum has a section-weight of 120 per yd. An example of the latest type A.I. flash butt welder, designed to handle rails up to the present maximum section, is shown in Fig. 9. Designated the type APHF/30. R., it gives a maximum forging pressure of 30 tons. A feature of the machine is that the forging and clamping motions are actuated by a patented system based on the use of air/hydraulic intensifier cylinders. Air pressure, at 80 to 100 lb./sq. in., is supplied directly to the cylinders, and the need for separate accumulators, hydraulic pumps, air-receivers, and associated pipe-work, is therefore avoided. The working loads are readily adjustable by means of reducing valves which control the pressure of the air-supply to the cylinders.

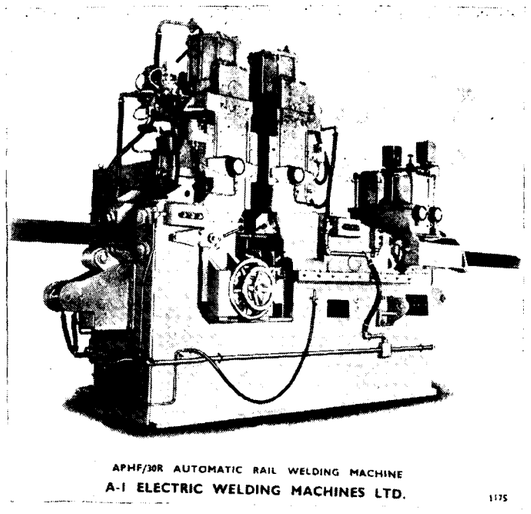


Fig. 9. The A.I. Type APHF/30.R. Rail Flash Butt Welder, which will handle sections weighing up to 120 lb. per yard. It incorporates self-contained air/hydraulic intensifier cylinders.

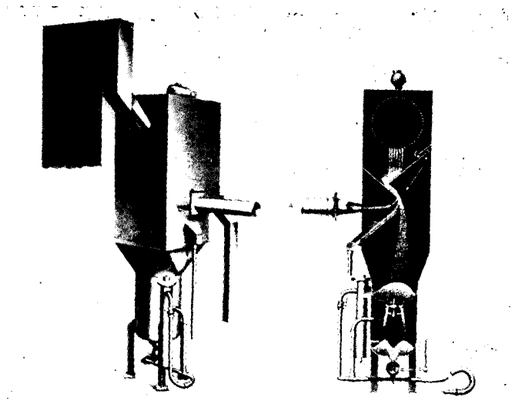
The vertically-disposed electrode clamping-heads can each exert a maximum load of 45 tons, and provision is also made for aligning the ends of the rails after the clamps have been applied, as on the APF/40 machine. Here, again, the entire cycle, including preheating, is fully automatic, and the heating, flashing and forging strokes are readily pre-set by reference to corresponding scales. Air-operated elevating rollers are incorporated at each end of the machine, and are employed to raise the welded rail clear of the lower dies, so that the latter are not worn or damaged by the work being dragged over them. These rollers are controlled by means of push-buttons, conveniently grouped, with the other main controls, at the front of the machine, and are interlocked so that they cannot be raised until the clamps have been withdrawn.

Available for use with the machine are pneumatically-operated rail alignment units, designed to facilitate the handling of the rails, as they are fed into and out of the machine. Each such unit comprises four horizontally-disposed pneumatic cylinders, and each cylinder carries a roller. Two cylinders at the front oppose two at the rear, and, of larger diameter than the latter, operate against fixed stops. The front roller thus move forward to a predetermined position, and the work is held sideways against them by those at the rear. When so engaged by the rollers, the work is held in accurate alignment with the electrode clamps, and the necessity for obtaining this initial alignment manually is avoided. Thereafter, all that is required is to apply the clamps, release the rollers, and obtain the final vertical and horizontal alignments by means of the appropriate handwheels.

Sand/Shot blasting—Its application in Railways and recent developments

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

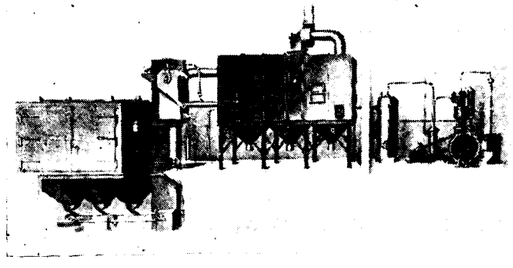
SPEED is the essence of modern life—the quicker the job, the lower the costs and nowhere more than on the railways is this of such vital importance. For obscuring glass panes of lavatory windows of railway carriages, for cleaning iron and steel castings, for removing scale from steel sections as well as rust from all types of steel structures and for a multitude of other similar purposes, sand blast is the only satisfactory answer to this problem. Though primarily employed by the glass industry, it has in the course of time conquered many other fields of application and now constitutes one of the many mechanical aids of outstanding merit available to the workshop engineer.



Shot blast Apparatus with abrasive and Dust separator and incorporating a sectional view of both the separator and pressure chamber.

EARLY HISTORY

The sand blast process came into being as a result of noticing the matting effect of sand storms upon the glass windows of a house on an American prairie, and in about 1870, Gen. B. C. Tilghman of Philadelphia first applied it to practical purposes and took out the original patent for sand blast machines. Tilghman's sand-blast consisted of a contrivance for impelling, with graduated degrees of velocity, a jet or column of sand by a blast artificially produced (of steam in some cases, of air in others) against the object or surface to be acted on. The operation excited great interest when shown in the London International Exhibition of 1873.



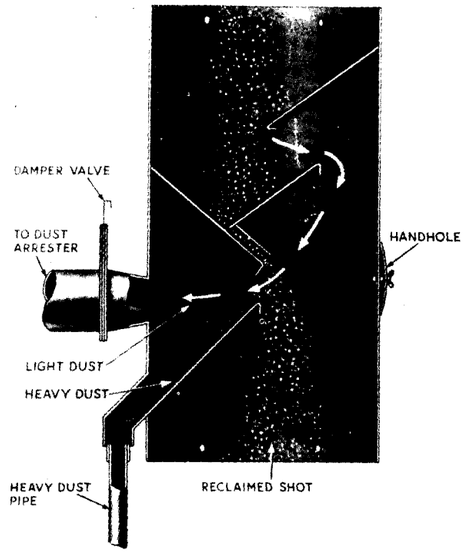
Complete Shot Blast Room installation.

The process was first applied to obscure, engrave and ornament glass, and later, to carve deep patterns in granite, marble, and other hard stones, to bite into steel, dress and sharpen files and even to cut and perforate holes through these and other most refractory materials.

In 1875 inscriptions were cut by means of the blast on 150,000 tombstones of soldiers killed in the American Civil War. Cast iron letters were fastened by shellac on the marble the sand was driven by steam pressure of 90 lbs. and the stone was cut in 4 minutes, to a depth of a ¼ inch, leaving the letters in relief.

While the use of steam for producing the blast was considered most simple and economical, many practical difficulties arose in its employment and consequently for obtaining high pressure of air, costly apparatus was required, thus limiting the applications of the agency. In 1884, Mr. Mathewson patented an apparatus in which, by an ingenious exhaust arrangement, the impelling steam was swept away, leaving only cool, dry sand to strike against the object acted on.

It is however to be noted that the particles of sand will cut only hard substances but not soft ones—a result due to the fact that each particle makes a minute cavity at once by direct impact when the receiving surface is hard, whereas a softer substance acts as a buffer or elastic rebounding cushion. A plate of glass covered with wire gauze may, by the action of the jet, be pierced and converted into glass-gauze—a curious effect obtainable by no other means.



Sectional view of Pneumatic separator which is used to ensure only clean abrasive reaching the hopper.

Internal view of large Shot Blast Room.

SHOT BLAST

Owing to the danger to health in the use of sand, it was gradually superseded by chilled iron shot, grit or Blastyte. Sand is now prohibited as an abrasive except in a wet state and is used for items of jewellery, silver plate and similar articles. Further research with these abrasive opened up new avenues and with the use of iron shot in a large number of cases, the term sand blast has now been replaced by shot blast which is now used for many other special operations, in addition to all the original processes which are constantly being improved.

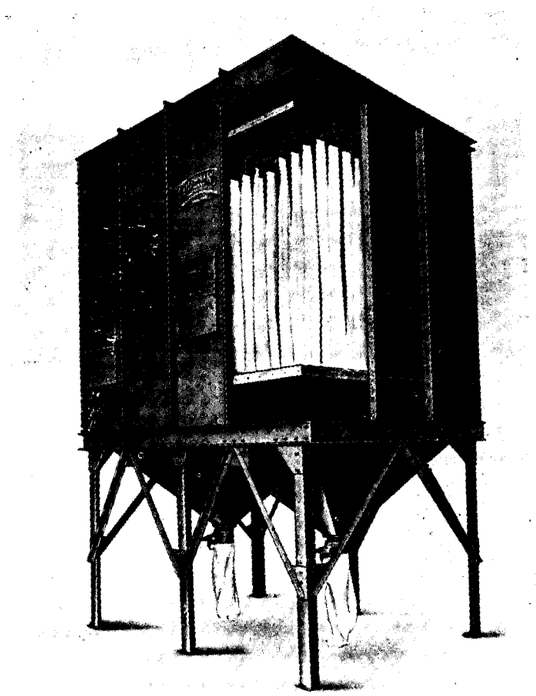
ITS VARIOUS USES IN RAILWAYS

The most important field of application for the shot blast is in metal working departments of the railway workshops, where laborious and disagreeable manual work has to a large extent been replaced by work with shot blast. In the Smith's shop, for example, shot blast is being used for cleaning drop stampings, forgings and billets, etc., with amazing speed and efficiency. Similarly modern foundries use the shot blast extensively for cleaning their castings. This work is done so thoroughly both on the outside and the inside of the castings, that all the troubles previously experienced from imperfectly cleaned pieces, e. g. blunted cutting tools due to sandy spots, leaks which escaped notice during inspection, etc., have completely disappeared. This thoroughness has been to the fact that shot blast reaches the remotest corners unapproachable by hand. Steel castings, which often show spots of burnt-in moulding sand, can be cleaned economically only with shot blast.

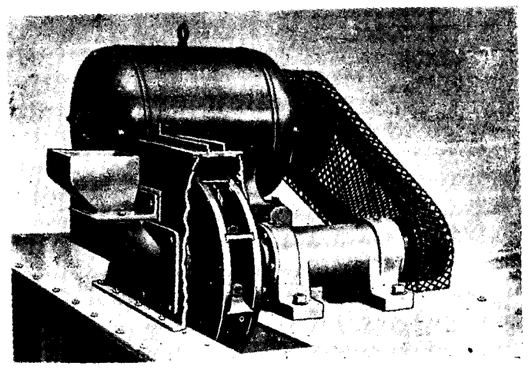
In affording the most effective preparation for every kind of surface treatment, such as galvanishing, nickel plating, enamelling, and so on, shot blast plays no less important part. The advantage of shot blasting in such cases is that by controlling the type of abrasive and the pressure of the blast, the surface of the metal can be "Keyed" in preparation for subsequent finishing.

Shot Blast is also used with advantage to remove the oxide skin and other kinds of scale from metal sheets and other rolling mill products and has in this respect replaced the old-style process of pickling in the acid bath. The coat of paint applied to shot blasted sheets shows no tendency to blister as in the case of pickled sheets, where traces of the acid are liable to survive behind rolled-in slag particles in spite of most conscientious neutralizing with milk of lime. It is for this reason that locomotive boilers and panel plates of carriages are cleaned with shot blast.

In bonding rubber to metal, the surfaces are generally prepared by shot blasting before gluing with the compound. The life of a file, an indispensable tool of frequent use in all workshops can be multiplied many times and efficiency greatly increased by cleaning and then regular sharpening with sand blast.



Sectional view of Dust Arrester employed to ensure a dust-free atmosphere in the workroom.



View of Wheelabrator Unit consisting of an electric motor, V-belt drive, shaft bearings, abrasive feed and wheel.

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In view of these manifold uses developing in the course of many years, many different types of sand/shot blasting machines have been evolved to enable the various kinds of work to be carried out greatest perfection and in the most economical way.

SHOT BLAST ROOM

Among the different types of sand/shot blasting equipments available, the shot blast room is a convenient method of treating a wide variety of relatively heavy parts. It allows close proximity of the operator to work with the resultant advantage of dealing with intricate parts.

A complete standard shot blast room installation generally comprises :—

(a) Shot blast room or operating chamber with the collecting hoppers.

(b) Automatic abrasive conveyor and bucket elevator for the return of the abrasive material to the shot blast apparatus.

(c) Automatic rotary screen and dust separator, the dust being taken away from the abrasive by means of the main exhauster.

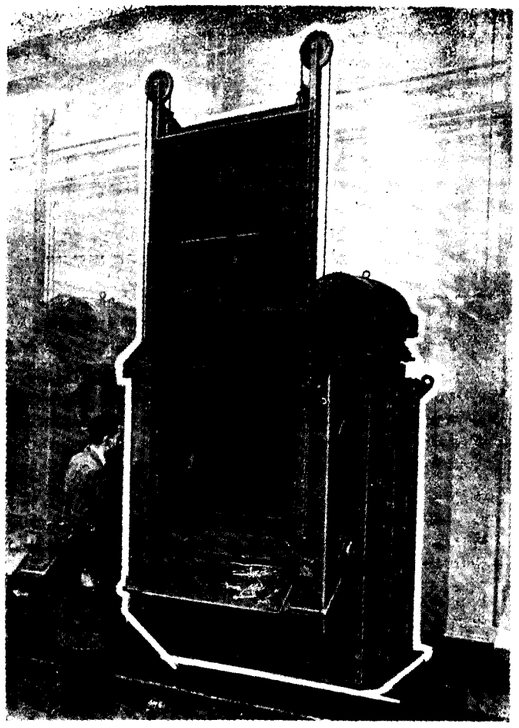
(d) Dust arrester for removing the dust before the exhaust air is discharged to the atmosphere.

(e) Exhauster for ventilating the room.

(f) Complete air compressing plant consisting of electrically driven air compressor, after cooler and air receiver.

Until early thirties the abrasive and dust were separated by means of what was known as suction system. In this system the spent abrasive used to pass by gravity through steel perforated grids forming the floor of the room to the bucket elevator for re-use and the dust was also drawn away by the exhaust system through the floor. The process was however found to be both less efficient and uneconomical in as much as for an effective displacement of the atmosphere of the room, the dust-laden atmosphere had to be exhausted for not less than five times per minute.

The system had to be discarded therefore in favour of direct pressure system incorporating the use of pressure chamber, fitted with abrasive and air mixing tube at base. During the process of blasting, both the pressure chamber and air mixing tube are under equal pressure and the abrasive falls into the mixing tube by gravity.



The cleaning of large quantities of small components is best done in a Tumblast Wheelabrator shown here.

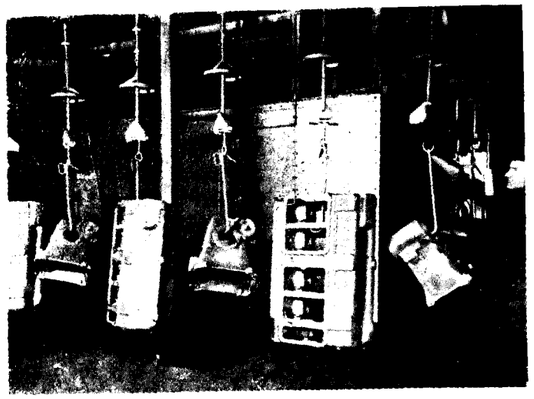
Increasing the tensile, strength of laminated springs by shot peening is accomplished most efficiently by this type of Wheelabrator.

The abrasive entering the mixing tube is projected through the flexible rubber blast pipe and nozzle. To ensure clean abrasive being used during every cycle of operation, an apparatus known as automatic rotary screen and dust separator is used above the pressure chamber. This pressure unit now forms the basis of the more efficient and automatic shot blasting equipments of to-day, in all of which it is incorporated.

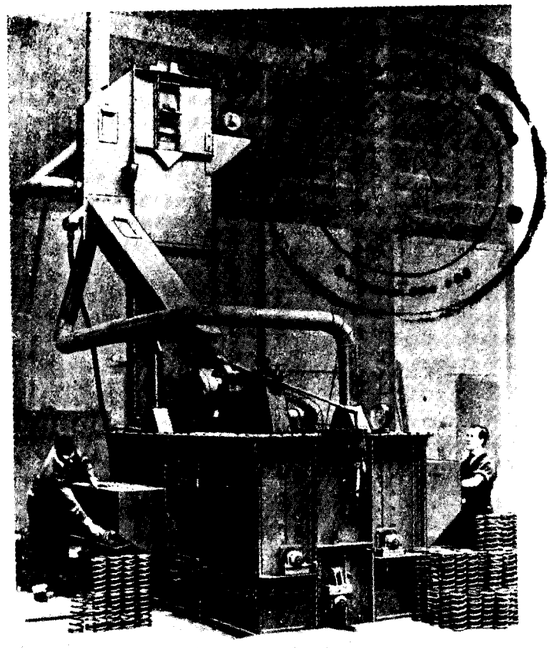
The shot blast room is composed of a strongly fabricated frame made from angle and tee sections and is enclosed with heavy steel plates. The whole thing is mounted on a strong girder base in order that the room can be easily erected on brick work or concrete foundation. The floor is composed of perforated steel plate, and underneath is a welded steel hopper (or hoppers), the upper flanges being bolted to the angles at the base and the lower delivers into the boot of the bucket elevator. As the abrasive falls through the perforated plate to the hopper and is conducted to the bucket elevator, it is raised and discharged into a rotary sieve in the top of the separator by means of a rubber and canvas belt on which are fitted suitable steel buckets. Provision of either screw conveyors or belt conveyors from the hoppers to the boot of the bucket elevator allows for shallower pits and eliminates the necessity for a relatively deep pit otherwise required for the hopper to deliver directly into the bucket elevator, because of the angle of repose of shot in the corners of the hoppers being about 40°. During the operation the room, bucket elevator casting and settling chamber are all under the action of the exhaust system in order to take out dust.

The automatic rotary screen and dust separator has a pneumatic device fitted at its top chamber for removing the dust from the abrasive. While light dust is drawn out by the exhaust system working in conjunction with a dust arrester, heavy dust comprising bits, nails etc. are taken out through a separate pipe allowing reclaimed shot thereby to fall into the pressure chamber.

The dust arrester which is used in conjunction with the shot blasting plant comprises a steel plate chamber into which the dust-laden air is drawn by exhaust fan. Inside the chamber are fabric dust tubes of an area such as will effectively remove dust from air drawn in. The dust tubes are individually suspended on hooks at the top and have sealing rings at the bottom which can be readily fitted into apertures in the bottom plate of the dust arrester. A hand operated vibrator device is fitted for giving vibration to the dust tubes (to be operated when the exhaust fan is shut down) to remove adherent dust.



Overhead Conveyor type Wheelabrator used for such work as crank cases, cylinder blocks etc. The conveyor trolleys are fitted with rotary hooks which rotate the work pieces as they pass through the abrasive streams.



Coil springs are shot peened too as shown in the picture for obtaining increase fatigue life by inducing compressive stresses in the surface.

For the easy conveyance and manipulation of the work, shot blast room plants are sometimes equipped with turn tables, runways, bogie rails, roller conveyors and when preferred with a revolving table installed half in and half out of the room for convenience in loading and carrying out an almost continuous operation.

Shot blast room are generally designed to handle cast iron and steel castings, ranging from 1/2 cwt. to several tons in weight and their areas also accordingly vary from about 6 feet square up to, say 50 feet long depending on individual requirements and space available.

Just as the room plant is installed where a wide variety of relatively heavy parts are to be treated and the output is sufficiently large, so is the cabinet type of machine employed where general light work is contemplated. In the cabinet type, the greatest advantage lies in the fact that the operator works from outside with the aid of window for sighting and gets a greater personal comfort in as much as he is free from dusty atmospheric conditions. In this machine, two arm holes are provided, one for directing the jet and the other for manipulating the work so that adequate treatment at special point is ensured in the same way as though the operator were in a room.

TUMBLING BARRELS

The shot blast plant of the tumbling barrel principle is the most effective economical method of cleaning small castings and forgings in bulk. Compared with shot blasting processes described earlier, this is a very slow process, but this slowness is advantageous, as it results in the work faces being given a polished, burnished finish arising from constant rubbing together of the castings or forgings dealt with.

A complete installation of this type of plant comprises, the tumbling barrel, a shot blast apparatus, dust arrester and exhaust system and the compressed air supply.

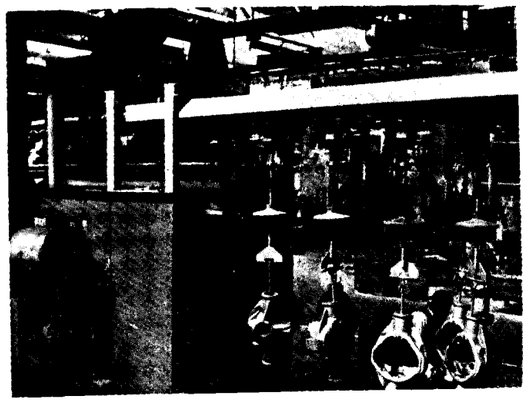
The operation may be described as under :—

In the tumbling barrel which consists of a strong perforated steel cylinder, the work pieces are placed and the cover fastened. The barrel is fitted with cast iron end plates which form a roller track, supported on its periphery by four rubber-covered rollers, on which the barrel slowly revolves at a rate of about 3 revolutions per minute. The barrel is fitted inside a strongly-constructed cabinet with counter-balanced lifting door with balance weight, rope and pulley. This lifting door is kept closed when the plant is in operation, forming a dust-tight chamber. The blast is directed from one or both ends of the barrel striking the articles placed therein at

a position where the bulk is concentrated. As the barrel slowly rotates, the articles inside, tumble over each other, bringing new faces under the action of the blast. The abrasive and dust pass through the perforations in the barrel into the cabinet from which dust is drawn of by the exhaust system to the dust arrester and the spent abrasive falls by gravity into the mixing chamber or, in the case of the larger installations raised by a bucket elevator and dropped by gravity into the separator. Whatever type of barrel is used, to prevent dust escaping to the atmosphere it is necessary to maintain a partial vacuum in order that the leakage of air shall be inwards. Sometimes a chute for the cleaned articles is fitted under the barrel to facilitate the loading of trucks from the apparatus.

AIRLESS WHEELABRATOR

Mechanical impact blasting by means of wheelabrator probably represents the most important development in shot blasting machinery. This amazing device patented

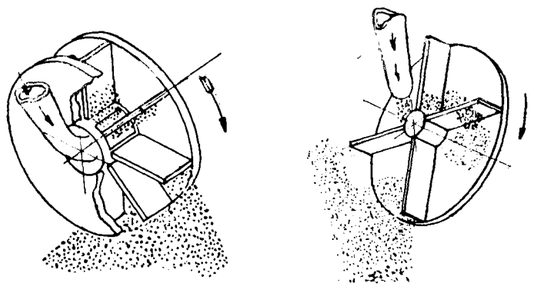


Two-wheel Overhead conveyor type Wheelabrator used for cleaning transmission housings etc.

by the American Foundry Equipment Co., Mishawaka, Indiana, has unquestionably set the highest standard of efficiency ever attained in an abrasive cleaning machine.

The greatest advantage in this process is that no compressed air is required, as a result of which such equipments as air compressor plant mixing chamber, piping, hose, nozzles, control valves etc. can altogether be eliminated.

The wheelabrator is composed of two main parts viz: the abrasive throwing wheel which throws out the abrasive centrifugally and that part which passes the work to be cleaned under the action of the abrasive.



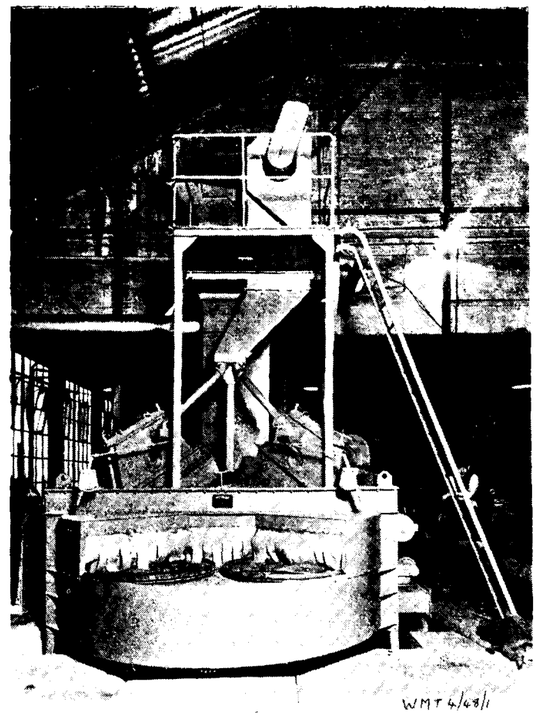
Slider type and Batter type abrasive throwing wheels. In the slider type, shot is guided from a central control cage outwards on to radial blades and in the batter type, the abrasive is fed on the open side of the wheel, the other side being a single main plate on which are mounted the blades, and the abrasive is discharged at the periphery.

The abrasive throwing wheels are generally of two types, viz., the batter type and the slider type. In the batter type there is one single main plate on which blades, made from abrasive resisting alloy iron, are mounted. Abrasive is gravity fed on the impeller blades of the wheel at an angle and is ultimately discharged at the periphery by the blades. The setting of the shot nozzle in relation to the blades determines the direction of the throw of the abrasive.

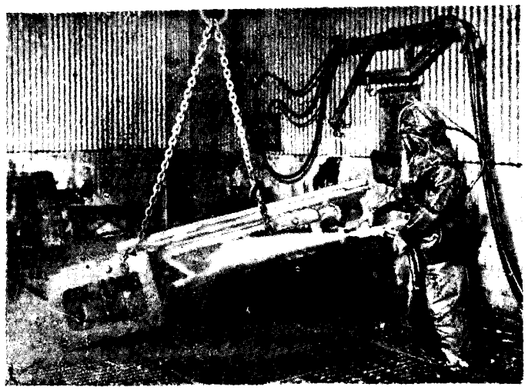
In the slider type abrasive propelling wheel, made of two steel plates bolted together with distance pieces, shot is guided from a central control cage outwards on to eight radial blades of special hard alloy iron. By rotating the control cage, the abrasive may be made to leave the wheel in any pre-determined direction. Abrasive is fed from the storage hopper by means of the feed funnel and feed spout to a small impeller wheel secured to the main wheel and revolving at the same speed while the control cage is held stationary. Through the slot of the control cage the abrasive passes on to the inner edge of the blades at a very low velocity and from this point the shot slides by centrifugal force to its discharge from the outer edge of blades which corresponds with the periphery of the wheel.

The wheel which is overhung on the end of a shaft held by two bearings is driven by a V-rope at a speed of 2,250 r. p. m. which has been carefully determined as the wheel become ineffective when the speed falls below this figure. It has been observed that at a speed of 1,800 r.p.m. the effective work obtained is only about one half of what it would be at the correct speed.

After cleaning the components, the spent abrasive falls by gravity into the boot of a bucket elevator which raises



Multi-rotary table Wheelabrator Machine.



Lathe bed Casting under the action of HYDRO-BLAST Gun.

it to the top of the cabinet and discharges it through a sieve which separates all foreign matter. At the same time the flow of shot is "washed" by streams of air drawn through the sieve by means of the dust extractor. The clean abrasive then falls into the storage chamber and is then fed by gravity into the centre of the wheel for re-use.

The second part of the wheelabrator plant differs in each type. The work is brought under the action of the abrasive by such equipments as endless chain conveyor, which, connecting with two circular plates, forms a barrel, rotary tables of the plain table or multi-table design, flat belt conveyors, roller conveyors, overhead conveyors and so on.

TUM BLAST MACHINE

The barrel type of what is commonly known as the tum blast machine is the first one to which the mechanical impact blasting principle was applied. This has still the widest application and is of the most popular type being very suitable for dealing with large quantities of small components. As in the case of direct pressure tumbling barrel, the materials handled are cascaded one over the other and completely brought to the full abrasive blast action. The operation, being carried out in an enclosed chamber, is considered as the most hygienic method. For quicker production, the machine is equipped with bucket leader, operated electrically for loading the charge while it unloads itself by reversing the endless chain conveyor whose movement is also controlled electrically

The wheelabrator rotary table or multi-table machine and the flat belt conveyor type are primarily intended to deal with work of a flat nature. In these machines if both the surfaces are required to be cleaned, the work will have to be turned over and passed in again so as to present the fresh surface to the impact of the abrasive stream.

For cleaning large forgings or castings of uniform shape, an overhead conveyor is used to pass them through the cleaning chamber. The components are suspended from the overhead conveyor (the roof of the room and vestibules having rubbered slots for the passage of slings). The conveyor trolleys are fitted with rotary hangers, which by means of a secondary drive are caused to rotate for rotating the components as they pass in the line of abrasive. The arrangement is such that each hanger gives one complete revolution for exposing the complete surface to the action of the abrasive stream, so that cleaning may be completed in one pass.

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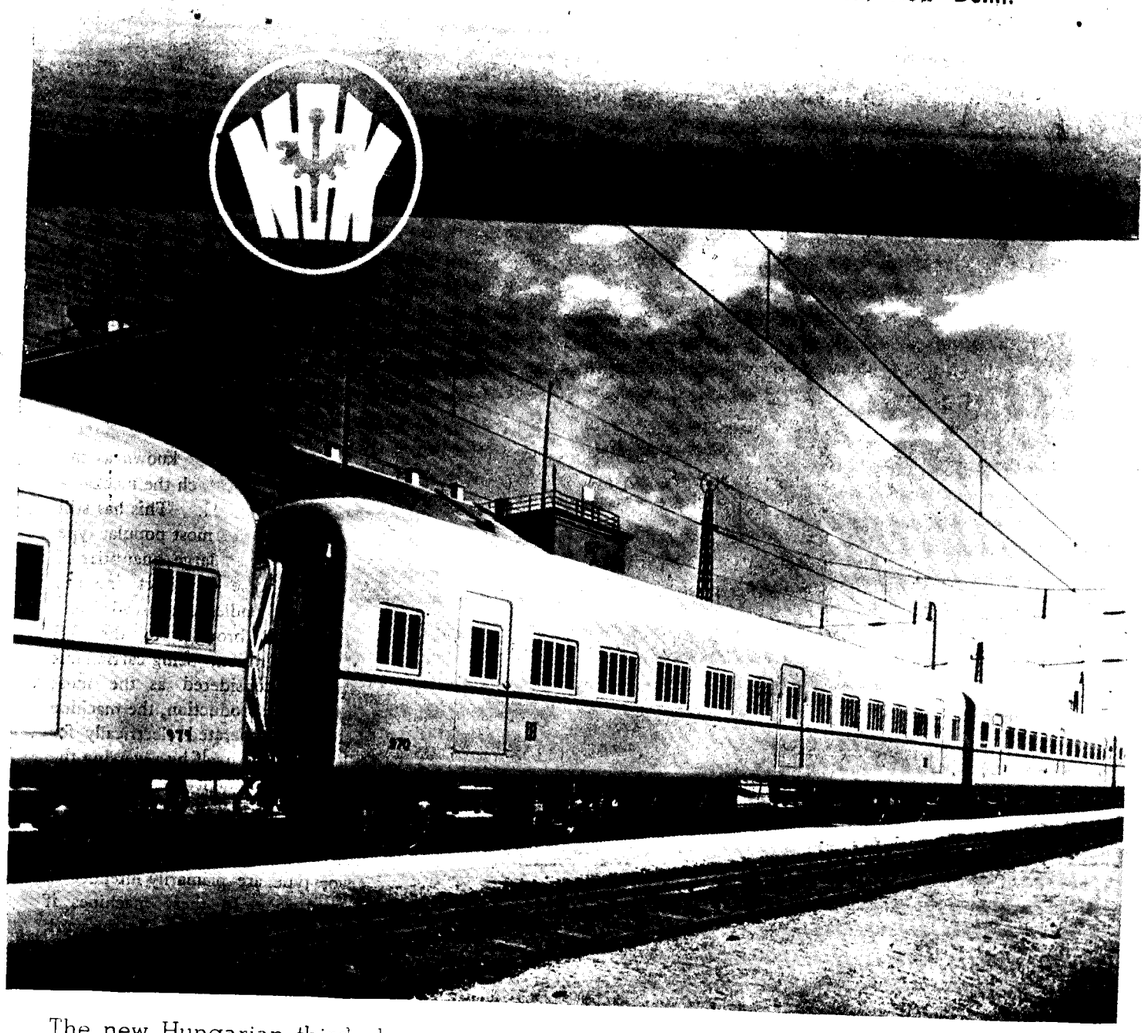

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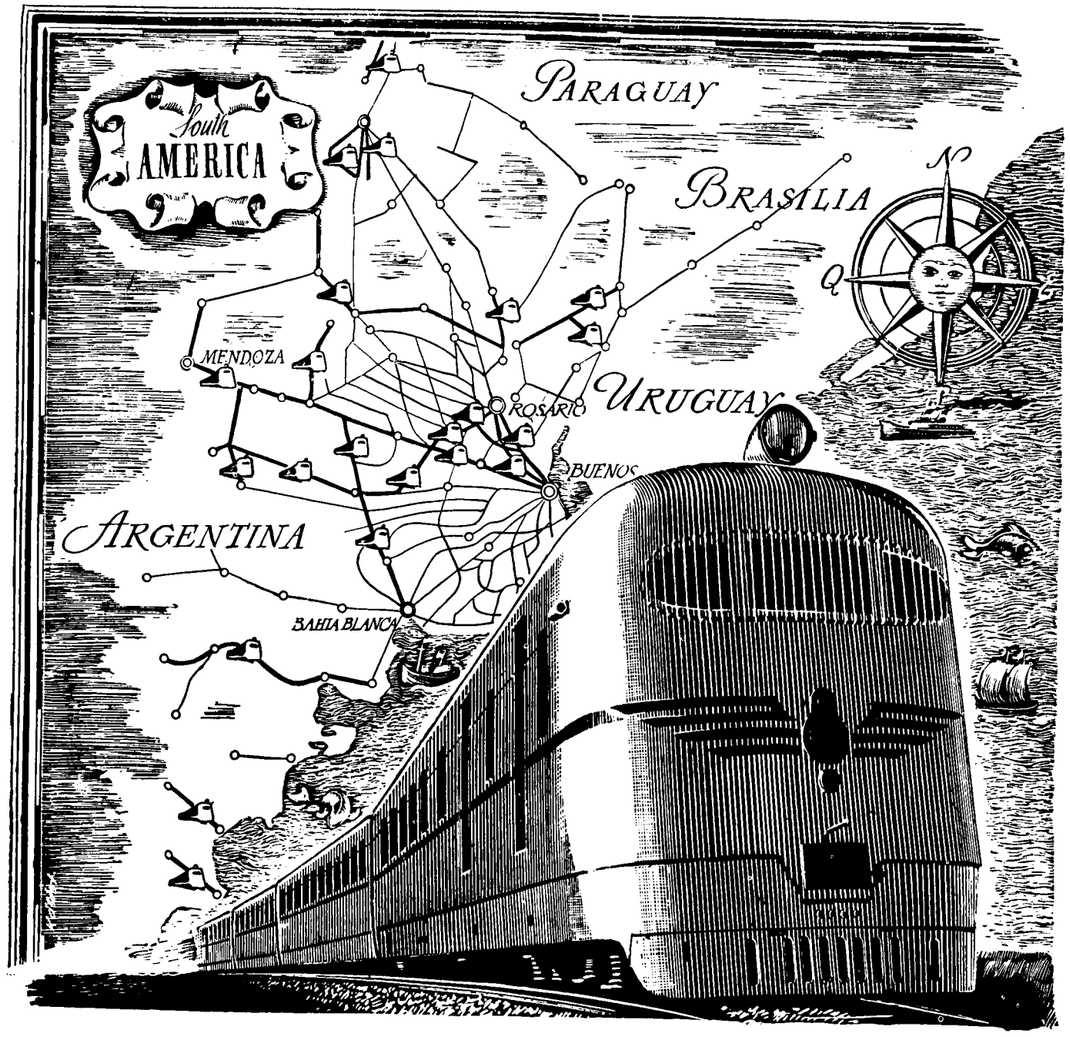

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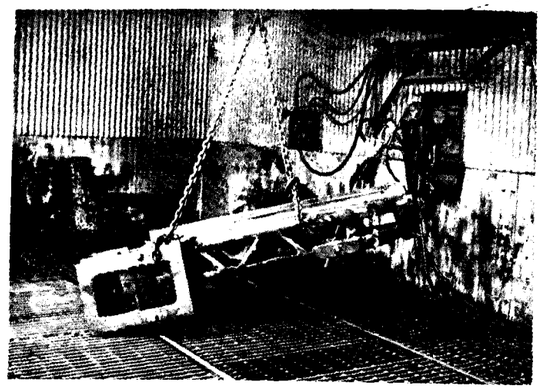
SHOT PEENING

Shot peening, which is a cold work-hardening process and designed to increase the tensile strength of springs in addition to removing any slight surface scale formed during the heat-treatment process, represents another development of shot blasting.

In this process, steel or iron shot is impelled against the surface of the spring at a relatively high velocity, either by an air-blast, or centrifugal force. The latter system known as "Whee!-a-peening" is more popular specially where a reasonably accurate control of the peening intensity is required. It is because while the speed of the impeller wheel can be determined precisely, the air-blast pressure is always liable to fluctuate. Further in the air-blast system the nozzle through which the shot is forced out, liable to erode rapidly, as a result of which the rate of feed of shot on the workpiece varies greatly.



Lathe bed casting cleaned by the HYDRO-BLAST Process.

In shot peening each grain or shot acts as a peen hammer and the impact causes cold flow of surface, resulting in a re-distribution of surface fibres and consequent increased resistance to fatigue of the part treated. Depending on the nature of the metal and the intensity of the impact, which is its turn is dependent on the size of the shot, the velocity with which it strikes the surface, the weight of shot reaching the surface in unit time, and the angle at which the surface is presented to the stream, a cold work-hardening effect in the top layer, extending to a depth of 0.005 in. to 0.01 in. below the surface, may be obtained. Remarkable results in increased fatigue life have been obtained from the shot peening of springs, both leaf and coil and its application has also been extended to such items as torsion bars and other parts which are under bending or twisting stresses. It may be mentioned in this connection that it is always the tension side which is exposed to shot peening action so that the inner fibres in their effort to force the outer fibres to return to a shorter length than that at which the stretched fibres would tend to remain, produce a resultant compression in the outer surfaces and a tensile stress in them.

The equipment consists of a projecting device either in the form of the air nozzle or abrasive propelling wheel as already stated earlier, shot separator, shot stabiliser, shot adding mechanism, the work carrier and cabinet, and an exhaust system. The working principle is more or less on the same lines as those of the other shot blasting equipments described earlier.

HYDRO BLAST PROCESS

During recent years there has been considerable development of the wet cleaning process, which offers several important advantages over shot blasting, including the elimination of dust. By this process a stream or water or a chemical emulsion and sand is directed under pressure of approximately 1200 lb. per square inch on to the face of the material to be cleaned, through a nozzle connected to a flexible hose. The nozzle is usually of the injector type into which a mixture of abrasive and water is gravity fed and they are forced out by either compressed air or steam with a velocity in the region of 16,000 ft. per minute.

The flexibility of application of the hydro-blast is of immense help in removing hard and complicated cores of castings in addition to cleaning sand from the casting surfaces. The system is so designed that the core and moulding sand may be reclaimed either for moulding purpose or for re-use in the system.

The plant is more expensive than ordinary shot-blasting equipment and the quantity of work to be handled largely dictates the necessity for installing it. It is considered that where the quantity to be handled in a day exceeds 10 tons and the components are sufficiently intricate to make difficult the employment of shot-blasting, its installation is economically justified.

A more useful application of the plant lies in removing machining marks previous to polishing. For such purposes, the nozzle is presented to the surface at an angle and the abrasive solution or mixture propelled over the surface of the object evenly.

For easy conveyance and manipulation of parts to be dealt with, such equipments as automatic conveyors

turntables, belt conveyors etc., are arranged depending on individual requirements.

VACU-BLAST PROCESS

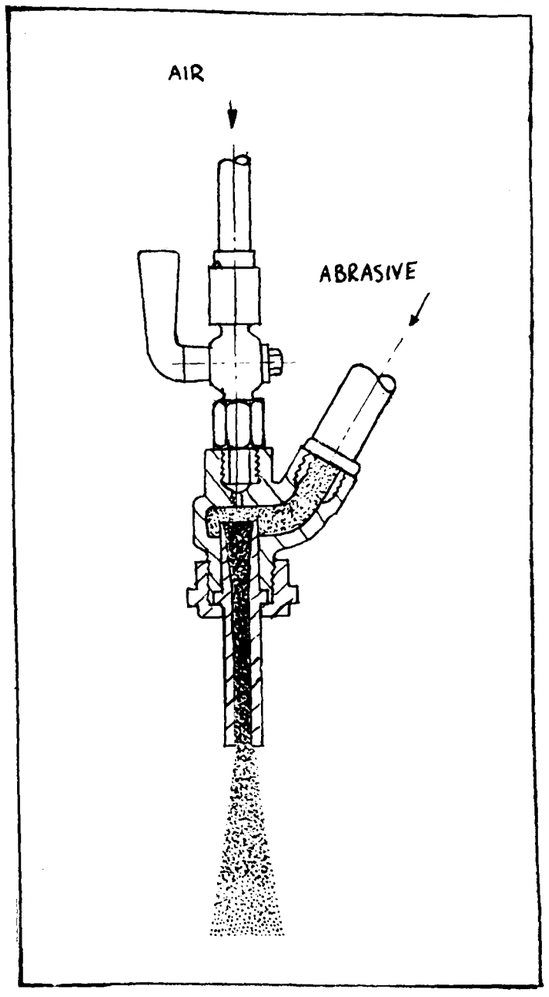
Vacu-blast is perhaps the most recent development in the abrasive processes and being a dustless blast cleaning method, having been originally developed in the U.S.A., is finding an increased favour in other countries as well. Furthermore its adaptability of being used as a portable unit has made it more popular in railway workshops where this is being used mainly for cleaning the panel plates of both wagons and carriages prior to painting.

The complete installation comprises, essentially three main units, viz: the blast gun, the abrasive control unit, and the dust collector. The blast gun may be used as a portable equipment or can be built into various types of processing unit. The portability of the equipment can be further explained by the fact that the blast gun can be operated effectively at a distance of 100 ft. from the abrasive control unit which in its turn may remain at a distance of upto 300 ft. from the dust collector. A completely self-contained and portable installation may be arranged by mounting the units on a chasis, together with a suitable engine driven compressor.

The blast gun made up of a cast aluminium alloy casing and weighing only 9 lbs., has a central blast nozzle of tungsten carbide with a bore diameter upto 5/16", fitted to it. A specially developed bristle and fibre brush, fitted at the lower edge of the casing, is so arranged that while resting on the surface of the work to be cleaned, it forms a seal to prevent the escape of spent abrasive allowing at the same time sufficient air to be drawn in for removing the abrasive and other impurities through the annular space between the casing and the housing carrying the blast nozzle.

The spent abrasive and dust is first drawn into the upper part of the abrasive control unit which is connected to the air compressor. The action of the unit is automatically controlled by means of an electro-pneumatic system. The function of the unit is to separate out usuable abrasive from the expended one and pass on other particles to the dust collector which incorporates a Root's type blower running at 1,100 r.p.m. and drawing 300 Cu. ft. of air per minute.

The usuable abrasive is first collected in a storage hopper from which it passes to an intermediate pressure storage tank and thence to a pressure feed tank connected to the compressed air supply line and fitted with a specially designed feed valve for feeding abrasive to the blast hose. Similar valves are also fitted between the



Sectional view of the HYDRO-BLAST Gun Nozzle.

storage hopper and the intermediate pressure storage tank, and between the latter and the pressure feed tank. The action of these valves is so controlled by the electro-pneumatic system, that the abrasive is allowed to pass periodically from the hopper, which is always under vacuum, to the pressure feed tank which is always under pressure from the compressed air, so as to ensure continuous operation of the gun.

The abrasive is fed to the gun through a soft rubber-lined hose which is connected to the pressure tank and incorporates two electrical leads terminating in a remote

control switch adjacent to the gun. The switch operates the specially designed air valves mentioned in the foregoing para and so long this switch is on there is continuity of supply of abrasive to the gun.

The power consumption for the electro-pneumatic system is 70 watt at 220 volts. The control unit is 6 ft. 8 in. high and weighs 8 cwts. while the dust collector is 6 ft. 3 in. high and weighs 12 cwts.

The blower in the dust collector draws as much as 300 Cu. ft. of air per minute through the gun, abrasive control unit and dust collector, as a result of which provision for any auxiliary supply of air for the operator, to ensure healthy working conditions, while working in enclosed spaces, is rendered unnecessary.

Although there has already been considerable improvement in the design features of the modern sand/shot blasting equipment commensurate with the new demands of Industry, continued research is still being carried on to achieve the ultimate in shot blasting practice and also to open up the avenues for the application of this process in other fields for reasons of economy and speed.

ACKNOWLEDGMENTS

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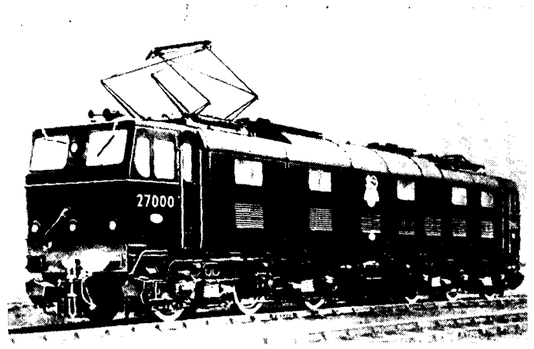
The Economics of Electric and Diesel-Electric Traction

By G. R. Higgs

There are various forms of electric traction with individual advantages and disadvantages. To decide which is the best for any foreseeable set of traffic circumstances is not always easy, but the decision once taken may be even harder to change. In carrying out modernisation plans it is therefore of the first importance that the traffic requirements—and potentialities—of every section should be studied in the greatest possible detail. The factors leading to the choice of one form of traction or another are discussed in this article.

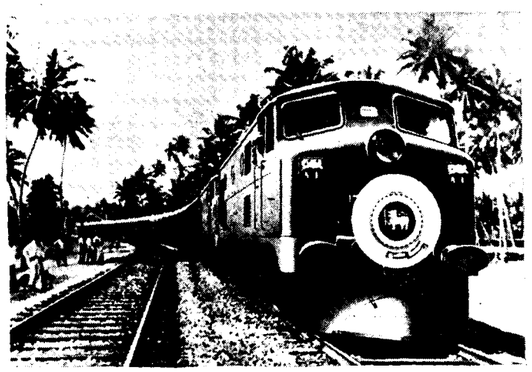
MUCH has been argued about the relative merits of the three established forms of railway motive power—steam, electric, and diesel. In Britain the field has now been narrowed (effectively) to the last two by the gradual elimination of steam traction from the purchasing programmes of most of the world's railways.



A six-axle electric locomotive of 2,760 h.p. used on the Manchester-Sheffield line.

To the question of which is the better there is, of course, no unqualified answer, since the correct choice must depend on many circumstances which vary from place to place and from time to time. As with so many engineering problems, the solution is determined mainly by economic considerations, and these will be better appreciated after a brief study of the technical features of the systems. The fundamental distinction between electric and diesel traction is in the method of transferring to the wheels of the locomotive the power obtained from the combustion of the fuel.

In electric traction the railway takes its power from the supply authority, which generates it in large power stations burning (in Britain) low-grade coal. After conversion from the three-phase standard frequency alternating form in which it is used in industry to one or other of the forms suitable for locomotive motors, the power is fed to the familiar overhead conductor contact system. The locomotive carries electric motors and control switches whereby the electric power collected from the overhead contact wire is made to drive the wheels.



A Brush Bagnall diesel-electric locomotive powered by a Mirrlees traction unit of 1,000 h.p, built for the Ceylon Government Railways. This engine pulled the royal train in which the Queen travelled in Ceylon.

In diesel traction, on the other hand, the fuel is a highly refined petroleum product, and the diesel engine in which its chemical energy is converted to mechanical energy is carried on the locomotive itself. The engine produces the power in a form unsuitable for direct application to the locomotive wheels, so that transmission by some other medium is necessary. This medium is almost always electrical, although hydraulic transmission is used in some countries, generally for special applications and for small locomotives. With electric transmission the engine drives a generator which feeds direct current to electric driving motors with control switches similar to those of an electric locomotive.

A Class X diesel-electric locomotive (Metropolitan-Vickers) on its inaugural run between Perth and Kalgoorlie, in Western Australia. It develops 1,105 h.p.

DECIDING FACTORS

From the nature of these fundamentally different arrangements certain characteristics derive which influence the choice of one or other, for any set of circumstances.

Weight for weight the electric locomotive costs less than the diesel.

For hauling the same trains electric and diesel locomotives must have the same weight on driving wheels, but the former, not being burdened with an engine and double power conversion, can be built to deliver much more power at the wheels than can the latter, and can therefore haul the trains at higher speeds and deal with more ton-miles of traffic per day.

Further, the absence of diesel engine servicing and maintenance enables the electric locomotive to give more hours of service per day and more days per year than its diesel counterpart.

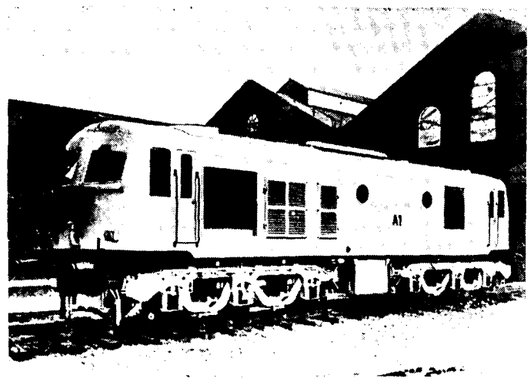
It is, therefore, obvious that traffic can be hauled by fewer and cheaper locomotives if they be electric than if they be diesel.

These considerations, however, apply only to one side of the capital cost question: the other concerns fixed installations. These are limited in the case of diesel locomotives to inexpensive fuelling plant, whereas electric traction requires an expensive overhead conductor system with substations to feed it. To the intrinsic cost of the overhead contact system must be added the often considerable cost of modifications to existing railway structures, signalling, and communications to accommodate it. The cost of this fixed installation is largely independent of the traffic density which it serves. It may be said, then, that where traffic is dense, requiring the purchase of many locomotives, the savings if they be electric rather than diesel outweigh the higher fixed installation cost, giving a lower capital outlay for electric traction. But where traffic is light the converse applies.

The foregoing reasoning has been applied particularly to locomotives on main-line passenger and goods services. On suburban passenger services there is much to be said for eliminating the locomotive and building the motive power equipment into the coaching stock. This is practicable for both electric and diesel traction, and the same reasoning will determine which involves less expenditure.

RUNNING COSTS

The principal running costs to be considered are for fuel, driving wages, and maintenance. Fuel costs are, of course, subject to changing prices, but at present are not very different for electric and diesel haulage.



A diesel-electric locomotive of 1,200 h.p. built by Metropolitan-Vickers for the Irish Republic.

Driving wages are also not dissimilar, though tending to be lower for electric locomotives on account of their somewhat higher average speeds. It is in maintenance costs that large differences are to be found. The diesel engine is a complicated machine, and servicing and repairs cost much more than for the electrical equipment and mechanical structure of the locomotive. Hence with electric traction the maintenance of locomotive is less expensive than with diesel traction, but an appreciable cost must be incurred for maintenance of the overhead conductor system and substations; this latter cost is almost independent of the traffic worked. Here again a lower running cost per ton-mile of traffic per day will be obtained with electric traction when traffic is heavy and with diesel traction when traffic is light. Depreciation charges follow the same pattern as maintenance charges for the locomotive and fixed installations.

Thus the total operating cost, being the sum of capital cost, depreciation and running charges, is less for electric traction in zones of high-traffic density, and for diesel traction on less heavily loaded lines.

Extreme cases are the intense suburban passenger traffic round larger cities where electric traction only can be considered, and goods marshalling yards where the speeds are so slow that traffic density in ton-miles per day on each track is too low to justify electric traction with its many miles of expensive but little used overhead contact system; diesel locomotives are well established in this service.

In the more general case, the determination of the critical density of traffic deciding the choice between electric and diesel traction on any route involves the study of many complicated statistics. It is, however, generally accepted that much more than half of British Railways mileage carries traffic denser than the critical figure and that most of the route mileage should eventually be electrified.

Economic considerations demand that this should be done as soon as possible, but limitations of technical man-power and the time-consuming processes of surveying the routes, clearing obstructions, and erecting the overhead contact system prevent rapid progress on large electrification schemes. Such limitations do not apply to the manufacture of locomotives, whether electric or diesel, and therefore Britain can most quickly cut her losses on inefficient steam traction working by changeing over the busiest routes forthwith to diesel traction, and at the same time putting in hand their electrification. When the work of electrification has been carried out the diesel rolling stock can be moved to less dense traffic zones and new electrification programmes started. In this way the two systems are complementary, and in due course a stable situation may be reached with each in its own most economic zone.

When the time comes for atomic energy to provide power for railways there need be no changes to electric traction equipment as the power supply will still be electric. The relation of its cost to the presumably rising cost of fuel oil will, however, dictate an expansion of electric traction at the expense of diesel traction.

LIGHTING & PRODUCTIVITY

By V. Ramamrithan and T. S. Natesan

THE emphasis today is on the human being in industry. No longer are operatives regarded as machines which function satisfactorily irrespective of the conditions in which they work, for scientific investigation and the common experience of recent years have indicated very clearly that both the quantity and the quality of output are improved by the provision of such amenities as can reasonably be made available. In other words, if people are made mentally and physically comfortable, they will do better work more willingly and incidentally with less conscious effort.

Save in exceptional cases, work is primarily dependent on sight. Physical actions are preceded and accompanied by work for the eyes—hard or easy work according to the conditions provided; mental reactions are very largely determined by what the eye sees. Therefore, it is obvious that any job for which vision is necessary cannot be done with individual maximum efficiency, so long as any restriction is imposed on the speed and accuracy with which the operator can gather the visual information he needs. Visual powers are variables depending within physiological limits and other conditions of lighting.

The level at which our latent visual capacities can actually operate varies with the stimuli intensities characterizing the field of vision and so with the prevailing conditions of lighting. This is so evident from one's common experience that no one would suppose for a moment that productivity in, say, watchmaking would be as good under the conditions of lighting usually available for the coal-miner, as it would be with much better lighting. But, of course, it cannot be said that the watchmaker must and will be more productive with good sufficient and suitable lighting than he will be under bad conditions; only he can if he wills. Good lighting is only permissive but not compulsive of good productivity.

To a certain extent good lighting is an incentive as well as a direct improvement of the conventional efficiency of the visual system. Thus if what needs to be seen can, in fact, be seen confidently at a glance, instead of requiring prolonged or repeated inspection, time is clearly saved as well as visual effort and possibly spoiled work, with a resultant availability of time and energy for more encouraged production.

Good lighting tends to promote increased activity spontaneously as a physical expression of the feeling of well-being and invigoration which, other circumstances permitting, is commonly promoted by liberal environmental brightness.

However, in spite of protracted industrial experiments, it is surprising that it could be sometimes disputed that good lighting is significant incentive to workers. This is more so when one considers the fact that during the last war, there was a considerable drop in productivity with disincentive effect of environmental dimness where the distribution of light was confined to the lower parts of the interiors and the visual field above working plane was surprisingly dark. One heard such workplaces aptly called "dumps".

The general responses which tend to be evoked by liberal ambient brightness, namely, cheerfulness, alertness and motor-vivacity are all in favour of good productivity whether the kind of work concerned calls for casual seeing or for visual discrimination of the highest order.

One might ask what would happen if the lighting is well matched to the job. The physiological effect is the limitation of visual acuity to a degree where it makes it impossible for the worker to make out the details of his work at a comfortable viewing distance. He has, therefore, to enlarge his visual images to bring them within his restricted resolving power. This he does by peering at the work. This close viewing increases the muscular efforts spent in seeing. All the muscles that are working to keep the two eyes focussed and oriented for the work are operating too close to their full capacity, and the early onset of fatigue leads involuntarily to relaxations of the gaze. The working illumination which is insufficient for occupational seeing to be carried on without a fatiguing posture and without physiologically uneconomic ocular muscle action, must necessarily prevent productivity from reaching the level that could be attained with sufficient illumination. But this gives rise to a question of how much illumination is required to permit a high level of working efficiency. The answer to this cannot be a single generally applicable value, for what is required to reveal minute and dark-coloured objects greatly exceeds that which suffices to make

much lighter and larger objects easily visible. Hence a code of standards has been evolved by the various illuminating engineering societies in the world based on actual field experiments throughout the world.

Even after providing sufficient amount of illumination vision can be difficult and imperfect if glare is present, but glare is a subject which has been studied for many years and though not perfectly understood even yet, can be reduced to negligible quantities in so far as the light sources are concerned, by suitable screening or diffusing media. There are other forms of glare however, which can only be removed by proper treatment of the working surfaces themselves, and these forms may not be immediately obvious to an observer. After days or months of exposure to them, however, their effect becomes very noticeable, though in many cases the cause very often remains unappreciated and ignored. There is an essential need for contrast in the field of view to enable detail to be observed. These contrasts may be either of brightness or of colour. Contrasts of brightness alone are difficult to arrange in ordinary industrial work, for metals, tools, machines and surroundings are apt to be of much the same colour and with comparable reflection factors so that unintentional camouflage effect is produced and can only be relieved by illuminating selected articles or areas to higher values than the surroundings. Sometimes this can be done satisfactorily by local lighting, but generally the provision of properly controlled brightness contrasts would entail a considerable quantity of finely adjusted apparatus which would not be welcome to the maintenance staff and would be liable to mishandling. The obvious alternative is the full and proper use of colour applied to the various surfaces normally seen by the operative, with the addition in some cases of reflecting surfaces to provide a background against which the work can be seen in silhouette.

Many jump to the conclusion that light colours are not practical for industrial interiors. Light colours are being used with utmost satisfaction and will certainly be used to an increasing extent for the very obvious benefits they bring viz , reflection of light (and therefore illumination from a given lighting system) is increased. The whole interior becomes less of a place of toil and more of a place where work can be carried out in a light, airy cheerful atmosphere.

The effects of age upon individual illumination requirements deserve some consideration, because we have an ageing working population and in the interest of national productivity the experience and skill acquired by those of long years of employment should not be offset by failure to meet their increasing light need. Apart from the gradual recession of the near-point of distinguished vision which goes on throughout life and which can be compensated for by glasses, there are other changes which tend to slow down the rate of visual performance and, to check this decline, stronger illumination of work is necessary.

Investigation has shown that the speed of visual discrimination of young adults doing variously exacting visual tasks is much less sensitive to the variation of illumination over a wide range than is that in middle-aged adults doing similar work. In other words a given increment of illumination conceded to the middle-aged worker is much more rewarding than it is to the young worker. To conclude this necessarily incomplete consideration of light and productivity, the effect of lighting on productivity could be summarised as :—

(1) The improvement in the speed of vision allows the operators quick accurate observations which are so vital in a visual mechanic's works.

(2) The maintenance of the plant is easier and if a breakdown does occur, it can be dealt with expeditiously without the use of temporary lighting. Spoilage through maladjustment of the plant or loss of production during a breakdown can cause a very serious loss within a short time with a highly rated plant.

(3) Operative and maintenance staff can move about the plant with confidence, avoiding obstructions and other hazards, thereby reducing the number of accidents, and accidents not only delay production at the time but even affect the morale of the remaining personnel.

(4) A well lit area is good psychologically and tends to improve manual performance. Most people feel more energetic and enjoy natural lighting which is generally much higher than artificial illumination economically maintained in a works.

The rate of production or the productivity is not directly proportional to the level of illumination, but it would follow a logarithmic relationship found between visual acuity in illumination. (Courtesy : Philips Light Bulletin)

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