PAPER No. 266

Modern System of Training Artisans and Technical Personnel

By

H. B. ADAMS, M. Ins. Loco Engrs., A. M. Inst. Mech. Engs., London, and A. M. I. E. E.

GENERAL REVIEW

The need of apprenticeships in Industry is evidenced by the great scarcity of properly trained Artisans and Technical Personnel. Conditions during the war have made it apparent that the future must be made secure by systematic and careful training of young men under a modern system of training.

In the old time apprenticeship system, the Apprentices were under the direct supervision of the Foreman in whose department they were employed and were dependent upon him for all the instructions they received. Some Foremen were good instructors and had the ability to train good Mechanics; others were poor Instructors, and the results were discouraging. Under modern shop conditions the Foremen, whether they are good or poor Instructors, have so many other duties relating to the productive efficiency of the Shop that it would be impossible to expect them to instruct or supervise the Apprentices to any extent. All that the Foreman can be expected to do is to give the Apprentice his work, briefly outline to him the method of procedure and see that his productive capacity and habits meet the requirements.

The natural outcome of this system is that Apprentices find themselves at a loose end in a Shop and become disinterested, and often disheartened, as climatic conditions play a natural part in dulling the brain and encouraging laziness. The logical result is, that from 50 per cent to 60 per cent of the Apprenticeship period is entirely wasted, the value of time is not appreciated, interest and initiative lies as dormant as at birth, the dawn of the realities of life only breaking when the Apprenticeship is concluded, and his market value assessed.

Fortunately there are a few exceptions who by their own initiative and enterprise have proved they have abilities, interest and desire to make the best of their opportunities, and invariably Apprentices of this type have their reward by readily obtaining any assistance and guidance they require from their Supervisors.

The climate of India cannot be overlooked when examining the conditions with which Engineering Apprentices have to contend, as concentrated effort of body and mind are adversely affected by extreme heat and humidity.

The above remarks indicate the absolute necessity for an Industrial Undertaking to arrange for the training and supervision of its Apprentices on a highly organised basis, and for the requisite facilities essential for efficient training, in order that the mutual obligations of Indian Industries and Apprentices may be faithfully fulfilled, with complete satisfaction to both parties.

Modern Methods. The modern development of the Manufacturing Industries has firmly established the principles of specialisation.

Specialised methods demand that more attention must be paid to the question of maintaining the supply of skilled workers by training Apprentices.

The changed conditions have also made it necessary that the Apprentice of to-day should be trained along broader lines than in the past—he must be taught some of the principles on which his work depends, as well as the mechanical operations, and he must be made to understand not only the methods, but the reasons for the methods, so that he can adapt himself to new processes when required. He must aim at becoming a Specialist in his own particular trade.

Grades to be Trained. Generally speaking, Industry is required to legislate for training Technical Personnel in the following Grades :—

(*a*) Engineering Course—'A' Grade for Administrative Posts.

(*b*) Engineering Course—"E and S" Grade for Executive and Supervisory Posts.

(*c*) Trade Courses—For Craftsmen's Grade.

A brief description of the training adopted in large Industrial Concerns in Great Britain is as follows :—

Course (*a*) Is a course of five years duration and is open to Graduates in Engineering from Universities of approved standing, or men who have completed satisfactorily a year's full day time course at an approved Technical College of University Standing. The Practical Training is continuous and carefully planned through the various Departments of the Factory.

Course (*b*) Is a general Engineering course for Executive and Supervisory posts, normally of five years duration and admits youths between the ages of 17 and 18 years who have passed the Matriculation Examination.

The policy is to combine the practical and theoretical training, the first six months of each year is spent in the Workshops and the last six months is spent at College. This form of training has much to commend it, as the Apprentice remains sufficiently long in the Workshops or College to permit of concentration on his work, and reap the maximum benefit. The whole course of five years is continuous, and the training is concentrated both at the Works and in the College.

At the discretion of the Apprenticeship Committee, at the time of selection, the length of the course may be reduced to four years for candidates who have higher educational qualifications, or varied for those who do not desire to take the complete Engineering Course, and wish to specialise in some particular branch of Industry requiring longer Workshop training. *This flexibility is essential in the case of large Engineering concerns on account of the variety of its products.*

Course (*c*) A general Trade Course for Craftsmen combines Workshop training with compulsory Technical Training at Night Classes for

two to three nights weekly at the Technical College. Apprentices showing special aptitude have the opportunity of transferring to the General Engineering Course and rising to Supervisory posts. The type and degree of Technical Training to be imparted will vary according to the standard and grade of Apprenticeship.

Systems of Training Apprentices. In the past there has been a wide divergence of opinion as to the most appropriate system to adopt, but modern thought favours the principle that, in order to insure complete success, Mental training must be parallel and simultaneous with the Manual shop training to ensure that the youth may understand his work, know his materials, understand his methods, and know the reasons for what he does. For this ideal, Night Schools alone will not suffice, Mental training must be provided by taking the School to the Apprentice; taking it in working hours at the cost of the Administration and compelling his attention to it, being as vital a part of his Apprenticeship as the trade itself. The brain and the hand must be trained simultaneously, and mechanical drawing offers the readiest educational medium for development. It will be noted that the Sandwich System of training is adopted for the Executive and Supervisory grade, also for Craftsman, but not for the Administrative grade. The reason for this policy is obvious, the principle of specialisation in Workshops demand that those Apprentices who are destined to be the future personnel of the manufacturing side of Industry, must weld their Practical and Theoretical knowledge into one solid foundation which is progressively built up year by year. This consolidation, reinforced by further experience in after years, guarantees that men with such training become valuable assets to the manufacturing side of industry. Administrative posts do not generally require that degree of specialisation which is so essential for the Executive and Supervisory posts.

The Sandwich System. The Sandwich System of Training can be applied in many forms, the type to be adopted depends on the class of Manufacturing, or Maintenance Concern, and its magnitude. For instance, the system selected by the Punjab College of Engineering and Technology from 1924 to 1934 whereby the apprentice spent one week in College, and one week in the Railway Workshops, for the first 30 months of their Apprenticeship, was obviously faulty, and a case of "a Rolling stone gathers no moss." For the past eight years, the system has been for the Apprentices to spend approximately three months continuously at the College and nine months in Workshops, actually a total period of 13 months Technical Training and 47 months Practical Training.

This system too is faulty in that the period spent in the College is too short, and it is now proposed that apprentices shall spend the first $1\frac{1}{2}$ years in the College, including the College Workshops, where they will be initiated into the use of tools, materials, etc., the remaining $3\frac{1}{2}$ years for Practical training in the N. W. Rly. Workshops.

Although this new proposal is an improvement over the two previous systems, my own view is that the Technical Education only is the function of the College, and the Practical Training inclusive of the initial training in the use of tools, etc., is the function of the Railway Workshops Apprentice Training School where, under the direction of the Apprentice Supervisor, and guidance of Selected Instructors who are specialised Skilled Craftsmen, bad practices are not seen, in fact not known, hence in future not adopted.

Man Power and Productive Capacity. Much has appeared about the Technical Training Scheme in the Press, but the immense possibilities that it holds for the Indian youth and the Industrialisation of the Country after the War has yet to be realised. There can be no doubt that when the War comes to an end, the many Factories which have been set up under the stress of War will be turned over to peace-time production, and that the thousands of skilled workers now being trained and further up-graded will become keymen in a new and progressive industrial India.

Success in any Industrial Undertaking is measured in terms of output, commensurate with economy and quality, and this is in direct proportion to, and entirely governed by the degree of skill attained and maintained by its employees, from its Administration down to the most junior semi-skilled artisan.

Industrial output is governed as far as its labour is concerned by the law of averages, *i.e.* the average output of the average worker based on a time study of the various operations. The greater the productive capacity in terms of man-hours of each individual the more useful he becomes to his Employer, and to Industry as a whole.

Each Country has its own standard of averages which is very largely dependent upon the standard of education, adaptability to a particular trade, physical fitness and climatic conditions.

In Western Countries it has been established that a very close relationship must exist between Education and Industry, and to this end Training Schemes are designed to promote the best interests of those Trainees displaying originality, initiative and resource, in all branches and grades of employment. These qualities can best be developed by continuing Education, side by side with Practical Training.

The training of Apprentices involves many responsibilities for which reason large progressive Industrial Concerns have lately developed the training and supervision of its Apprentices on a highly organised and efficient basis, in order to ensure that fully qualified men are available to replace normal wastage of staff, in the various categories throughout the entire organisation.

A Modern Training Scheme as adopted in Great Britain.

A brief description of a typical Modern Training Scheme is as follows :—

Apprenticeship Committee. The responsibility for controlling the Apprentices and their Course of Training is vested in an Apprenticeship Committee, the personnel of which is carefully selected from those Heads of Departme ts who are directly interested in the training. Personal Contact is an essential qualification and the ideal way of initiating the young Apprentice straight from school into the life of a large Industrial Undertaking. Personal Contact is, therefore, the key to success.

Selection of a Career. The Selection of a career is the most momentous occasion in a youth's life and as such every prospective Apprentice should start the course he has selected with a six months' probationary period. If he finds his work congenial and has satisfied the general conditions, he is admitted to a signed indentured apprenticeship commencing from the age of 16 years. The policy followed is one of continual encouragement, taking full cognisance of character, ability, and industry, making every effort to avoid placing a " square peg in a round hole," and ensuring that no obstacle is put in the way of the progress of the young Apprentices; no matter how humble his origin.

Professional, Technical and Practical Courses

These consists of four separate courses as follows :—

(*i*) *Students' Course.* (Administrative) (University and College Graduates).

(*ii*) *Engineering Course.* (Executive) (Technical College Students).

(*iii*) *General Trade Course.* (Supervisors and Tradesmen).

(*iv*) *Specialised Junior Tradesmen's Course.* (Tradesmen).

The Students' Course is of three years' duration and provides for a period of one year's Practical work in a modern Workshop and two years' full day time course at an approved Technical College of University standing. The object of this course is to equip suitable men for *Administrative* Engineering posts and for Industrial Management.

The Engineering Course is of five years' duration and normally admits youths between 16 and 18 years from Public or Secondary Schools who have passed the Matriculation Examination, or who possess School Certificates of recognised examining Bodies exempting them from passing the Matriculation Examination. The object of this course is to equip suitable men for *Executive* positions of responsibility in the Engineering Industry and provides for *two years concentrated Practical with three years' Theoretical training, or vice versa,* depending upon the particular type of career the students selects before commencing the Course.

The General Trade Course is of five years' duration and is bound by an Apprenticeship indenture usually commencing when the boy is 16 years of age, and terminating when he is not less than 21 years of age.

There is a very great demand for Skilled Craftsman of various trades in the Engineering Industry, Railways, Public Works, etc., and

for a boy with an ordinary educution and an inclination for Practical work, Craftsmanship offers a very interesting and remunerative way o earning a living. Should a Craftsman show the necessary ability, he may in course of time rise to the position of a Supervisor or other position of responsibility. This Course aims at producing highly skilled Artisans. Boys from 15 to 16 years of age with an Elementary education are accepted as Prospective Trade Apprentices, the younger group being usually employed on general utility duties in the Works or Office for a period of 12 months prior to commencing their Practical Training. The experience thus gained gives them some idea of life in a Factory and a general knowledge of the various classes of work in progress, which is very helpful when the time arrives for them to select a career.

During this initial period, it is compulsory for boys to attend a Continuation School in order to maintain and improve their general knowledge. During their Apprenticeship they must attend Night School at a Technical College. Where a Technical College is not available, Technical lectures by qualified Instructors are given daily at the Works, in order that Apprentices may acquire *Theoretical* knowledge of their work. These lectures are given within the normal working hours.

The Specialised Junior Tradesmen's Course, is given to selected youths between the ages of 17 or 18 years to 21 years, who are from Elementary Schools. They specialise on one particular Trade, such as Fitter, Turner, Machinist, Carpenter, Blacksmith, Moulder, etc. The duration of the Course, which is an essentially practical one, covers a period of three years. This type of training is particularly suitable for contracts for mass production, as the men, by virtue of their training, become expert in the manipulation of a particular class of machine or in performing a particular type of work. On completion of the Training, each youth is given a Certificate stating details of the Specialised Training he has been given in a particular Trade, or on a Group of machines.

Bonus Scheme. In order to encourage Apprentices to devote the whole of their energies to equip themselves adequately both Practically and Theoretically for their future, a special Bonus Scheme is provided. The bonus consists of two parts:—

(*a*) Service Bonus.

(*b*) Supplementary Bonus.

The Service Bonus is granted on the basis of the Foreman's monthly report as to whether the conduct, ability, interest, timekeeping and general progress displayed by the Apprentice during that particular month has been certified as satisfactory. No bonus is paid for any month for which an unsatisfactory report has been received.

The Supplementary Bonus is given to encourage Technical Education and is given as an annual lump sum bonus to each Apprentice who has passed the Annual Group Examination of the Technical College.

The Bonus Scheme outlined above is worthy of serious consideration, as it encourages healthy competition and development of brain and body, rewarding those Apprentices who deserve recognition.

Apprentice Training Room with Lecture Rooms. The initial Practical Training of Apprentices in all Courses is carried out in a separate building called the Apprentice Training Room which is fitted out with all the requisite equipment, machinery and lecture rooms for the various trades. Apprentices work under the guidance of selected Instructors who are specialised Skilled Craftsmen and able to impart the necessary Theoretical and Practical knowledge to the Apprentices.

All the Instructors are under an Apprentice Supervisor who directs the activities in the Apprentice Training Room and he is available at all times to any Apprentice requiring help or Guidance.

The probationary period of six months for each Apprentice is passed in the Apprentices Training Room and his acceptance for Indentured Apprenticeship is dependent upon the Apprentice Supervisor's report.

No Apprentice is permitted to be transferred from the Apprentices Training Room to the main Workshops until he has mastered the use of all tools used in his particular trade.

The North Western Railway Department of Labour Civmil Training Centre.

The Government of India Department of Labour Technical Training Scheme owes its origin to the Technical Training Enquiry Committee, which submitted its report to the Department of Labour at the end of July, 1940. The object of the Scheme is to train technical personnel in the shortest practicable time for the Defence Services, and Ordnance and Munition Factories.

The N. W. Railway Civmil Centre is not a Technical Institute or a Polytechnic, but a Training Centre accommodated in existing Workshops set apart specially for training. This is the largest Centre in India and has trained and passed out more trainees than any other individual Centre in India. Its success is due to the encouragement and support it has received from Sir Arthur Griffin, The General Manager, backed by all the resources of this Railway.

This Centre commenced to function on 3rd March, 1941, with a sanctioned strength of 50 Fitter Trainees. Considerable expansion followed within the year to meet the increased demands of the Defence Services.

The sanctioned strength in 1942-43 was 2,750 Trainees in 18 Trades as follows :—

1. Fitter.
2. Machinists.
3. Toolmakers.

4. C and T Smiths.
5. Turners.
6. Electricians.
7. Draftsmen Jig and Tool.
8. Wiremen.
9. Armature Winders.
10. Electric Fitters.
11. Engine Drivers (Internal Combustion).
12. Blacksmiths.
13. Die Sinkers.
14. Welders Electric.
    „ Gas.
15. Upholsterers.
16. Painters.
17. Riveters.
18. Boilermakers.

Recruitment was always in excess of sanctioned strength; the actual number on Rolls being invariably 4,500 Trainees.

For the training of these lads 40 Instructors and 200 Demonstrators were employed.

The magnitude of this Centre can be better judged by the annual expenditure which amounts to over 16 lakh rupees.

To enable this expansion to take place, new class-rooms, offices, store-rooms, dispensary, etc. have had to be provided and the training is now carried out in 'six hour-shifts' in the Centre, plus two hours Physical training in the Trainees Hostel.

Approximately 85 per cent of the total strength of Trainees are recruited for the Defence Services, these are known as Civmil (Enrolled) Trainees and are recruited by the Technical Recruiting Officers and their Assistants throughout the Punjab, N. W. F. P., Sindh, and Baluchistan. Recruitment for the *Civil* Trainees which only amounts to approximately 15 per cent, is carried out by the Punjab and N. W. F. P. Service Labour Tribunal.

The responsibility for organising and working the Training Centre on an efficient basis rests with the permanent Railway personnel assisted in the trades of Machinists, Fitters and Toolmakers by Specialist Instructors recruited from Britain.

The Group System of Training is adopted whereby the Trainees work in groups of 15 to 25 for Practical and Theoretical Balanced Training according to their Trades, each group receiving specialised individual attention by highly skilled, practical Demonstrators and

Technical Instructors. Lectures cover the use of all the tools, which they are required to handle, the knowledge of ferrous and non-ferrous metals, the calculations and data required for the respective Mechanical and Electrical categories. As Trainees are required to maintain note-books with sketches during the lectures, they have records which are extremely valuable in their work, assist them for trade examinations in the minimum of time, and will also be useful to them for reference in Civil employment after the War.

The Syllabus and Course of training is comprehensive in every detail and covers a period from six to eight months depending on the class of Trade. This basic training ensures that when a Trainee has passed the prescribed Course, he has a thorough ground work of his Trade, and is able to use all the tools of his Craft in the correct manner. Supervisory Staff for other Civil and Civmil Training Centres in India are also trained and up-graded at the North Western Railway Centre for the Department of Labour.

General Fitting. Fitting is a popular Trade as there is always a demand for good Fitters. The average number of Fitter Trainees in the Centre is approximately 1,000.

The ground work of Practical Instruction is essentially the correct method of handling tools with planned exercises to familiarise the Trainee in the use of the file, hammer, chisel hacksaw, etc. Further training stresses the necessity for accuracy in marking off with surface gauges, squares and dividers. Elementary figure filing and the fitting of male and female parts add emphasis to the importance of the marking off process. A thorough grounding in the use of the combination square and micro-meter is also carried out at this stage.

A curriculum of Balanced Instruction is followed, Practical and Theoretical, providing a general all round Basic Training.

It is essential for the Instructors and Demonstrators to exercise patience in the initial stages of the training, and to give individual attention and practical demonstration at the bench, vice, and marking-off table.

The elementary *Theoretical* Instruction includes explanations of the working tools and the care necessary in using them. The reading of blueprints is fully explained, together with the correct methods of grinding twist drills, chisels, scrapers, etc. The classification of files and their particular uses for different classes of work are described, whilst large charts and diagrams show the right and wrong methods of tackling a job.

Every mechanically minded lad is attracted by an engine, and it is his ambition to work on it, and see for himself how the wheels go round. This desire is the preliminary awakening of the latent Engineering instinct, and should receive encouragement in the early stages of the Training in order to create interest and keenness. Two Totally-enclosed Diesel Oil Engines each of 250 Horse Power have been placed at the

disposal of this Centre for training purposes in the Fitters Section. It may be of interest to state that these two Diesel Oil Engines came out to India for experimental Diesel Oil Engine operated Locomotives, but were originally designed as the power standbye units for the Airships R 101 and R 102. Airship R 101 was wrecked on its maiden flight to India. The Airship as a means of air transport, was abandoned and the engines are now utilised in the Civmil Centre for the purpose stated above.

Each Trainee after completion of the preliminary Basic Bench Work and Exercises covering a period of eight weeks, is now given a complete change, switched over to work for one week on dismantling and re-assembling the engines when he is taught how to use spanners, the names of all the working parts and accessories, a rough outline of the principle of the working cycle, and the general working clearances. Experience has disclosed and proved without doubt, that this popular innovation gives the Trainee an opportunity of visualising the scope of Fitting work, and creates keen interest. This diversionary stage at a critical period of the training is very beneficial.

At this stage the Trainee is in the right frame of mind to accept failure without undue despondency, and to try again until he attains happiness and satisfaction through success. If he breaks a hacksaw blade when cutting out a section of metal for his work, the reason for the breakage is duly explained by the Instructor, and the fault is corrected. Trainees are required to make all the tools necessary for bench fitting work, such as inside and outside Callipers, Dividers, Jenny or Odd Legs, Try-squares and to be able to repair and re-temper chisels, scrapers, etc. The blade of the Try-square is made from broken hacksaw blades, so that such breakages are converted to useful tools by the Trainee himself, and the cost of the breakage is minimised.

At the Intermediate Stage, the Practical side brings more advanced figure filing, and instruction is given in the scraping of flat surfaces to a Surface Plate, at which point the use of the Feeler Gauge is introduced. The training now includes the drilling of holes correctly, both for position and size—the Instructor showing how to "draw" a drill incorrectly started,—reaming, counterboring and tapping, also the use of Stocks and Dies, the selection of tapping size drills, and the correct procedure for handtapping and screwing.

The importance of datum lines and surfaces is impressed on the Trainee and he is initiated into the methods of using Height, and Caliper Gauge.

During this period, the Theoretical Training develops a knowledge of the various types of screw threads with their different forms and angles, the purposes for which each type is intended being fully explained. Similar explanatory lectures are given on taps and dies, screws, bolts and nuts. Gauging and Gauging Systems are introduced and the Trainee learns why he has to work to certain tolerances for the various classes of fits.

The more advanced stage can be reached quickly by those who take naturally to the work. Exercises are now more varied and include the chipping of keyways, drilling operations, and the correct methods of handling flat, and half round scrapers.

The gradual development of the training will be noted from the Curve progress (see annexures.) Variations are included as a departure from the set Curriculum in the form of Test Exercises, or may be production work, such as making spanners of different types and sizes, etc., for the Defence Department or perhaps Railway work.

On the Theoretical side, the Trainee is taught the importance of working to precision limits, the correct methods to adopt for the transfer of male and female measurements, and the metallurgical composition of metals. Lectures are given on heat-treatment covering the annealing, hardening and tampering of tools used.

It will be appreciated that such Fitter Trainees of outstanding abilities who have passed the Grade III Test can be up-graded as Tool Room Fitters, or as Oil Engine Artificers, or the Indian Air Force Mechanics (Civil), etc., so that the opportunities offering for this class of trade are very attractive.

Other Trades. Space does not permit of describing the methods adopted for training the other Categories. The policy applied, however, is "Waste not, want not," ordinary Railway scrap from the scrap yards being utilised, and whenever possible, this scrap being converted into useful Stock items. The various Training Exercises are designed with this end in view, and considerable economy has resulted. For instance Bench Lathes were urgently required for the Turners Section and could not be purchased, so 12 Simple Bench Lathes were made in the Training Centre by the Trainees, the components for which were manufactured as Trainee Exercises in the Fitting, Toolmaking and Turner Sections, and most of the material used was salvaged from the scrap heap.

I would mention two particular items of scrap which are re-claimed and converted into most useful articles in common daily use throughout the Railway from :—

(*a*) Old and unserviceable four gallon Kerosene Oil tins.

(*b*) Broken buffer and carriage springs from Rolling Stock.

Item (*a*) is taken over by the Copper and Tinsmiths Section who cut up and straighten out the deformed and twisted sheet tin. From it they manufacture pint and quart liquid measures, Oil Feeder Cans and Containers, Oil lamps, Funnels, Workshop Industrial Type of Lighting Fittings, A. R. P. Special Fittings and many other useful Railway Stock articles, thus effecting considerable economies.

Item (*b*) is taken over by the Blacksmiths Section and from it the Trainees manufacture all types of Chisels, Scrapers, Ball Peening and Cross Peening Hammer Heads, Metal Shears, etc., all of which are

utilised in the various sections of the Training Centre, the surplus being sent to the Railway Stores as standard Stock items.

On completion of the Training Course, the Trainees are required to pass a Grade III Trade Test, approximately 80 per cent of the total number recruited pass out and are posted to the Royal Indian Navy, the Indian Army, the Railway Military Transportation Group, Ordnance Corps, and Civil Industries employed on war work.

The next stage of their career is development and up-grading on more specialised work as the Fighting Forces or Industry require. This process of up-grading is clearly indicated under the Government Training schemes in Great Britain which is explained later in detail and given in the appendix.

In view of the rapid development and efficiency of the North Western Railway Centre, other Centres in India have been inspired to seek guidance in detailed training and the form of Exercises, Test Drawings, etc., which were prepared by this Centre for the Syllabus of Training, and accepted by the Department of Labour.

The land of Five Rivers and the neighbouring Provinces of the North-West Frontier and Baluchistan breeds a race of fighting men and potential Technicians. Under the stress of war conditions, opportunities for Technical training have attracted thousands of recruits of varying standards of education from the town and countryside. These youths and men are keen to learn a Trade, and readily absorb the instruction they receive on the Shop Floor, and in the Lecture Rooms. The results are very encouraging for the Technical Training Staff, and appreciated by the Trainees when they see the result of their effort and skill displayed on the Inspection Table. After the War, Technically Trained Craftsmen will be readily available for developing Technical Industries in the Towns and Villages to the benefit of all concerned.

Hostel for Trainees. A very important amenity has been provided in the form of a Hostel accommodating 3,000 Trainees which was an essential need, on account of the difficulty in obtaining accommodation and provisions in Lahore. This Hostel will, in addition to providing comfort for the Trainees, initiate them at the early stages into Discipline which is a very essential factor for the type of Trainees now coming forward, who are mostly recruited from the Rural Areas with no experience of Industrial life or surroundings. This Hostel is a great asset to the Training Scheme, as it provides comfortable living in healthy surroundings under the supervision of Army Personnel, who develop Discipline and arrange Physical Training and Sports after the Trainees have returned from their daily work.

Final Review and Recommendations on what has been Accomplished.

At the beginning of this world war, employers in Great Britain were faced with the serious difficulty of obtaining a sufficient supply of skilled artisans to meet their requirements, brought about by the tremendous

demands and expansion in the Engineering War Industry. Thousands of new entrants were put under training, the majority of whom had little or no experience, whilst many had never previously shown any aptitude or inclination for mechanical processes of any kind.

Industry called for immediate assistance from the Ministry of Labour and National Service Training Schemes which had been in existence from the period immediately following the last war, 1914-1918, for training ex-Soldiers in order that they could find useful employment. These Training Centres were well organised and efficient, adopting the most modern and advanced methods of training. The experience thus gained made it quite clear beyond doubt, that training carried out in highly organised Training centres had one great advantage over ordinary Factory Practice in that, the whole effort can be devoted to training, and undisturbed by the difficulties which arise in the need for maximum production.

Men trained under this system do not see bad habits, they are not known and therefore not practised. With the experience thus gained, Government were able to develop at once many more Centres, and quickly turned out into Industry many thousands of efficient craftsmen and technical personnel to meet the demand of the services.

A similar state of affairs existed in India, and Training Schemes under the Government of India, Department of Labour were organised in 1941 on similar lines to the schemes in Great Britain, and Specialist Instructors were brought out to assist in the Training. This scheme too has been working most successfully for three years, and has turned out large numbers of efficient Artisans for the Fighting Services and Munition Factories.

The System of Training whereby the period spent on Training is entirely divorced, at least in the initial stages, from main Factory production is the Ideal System, and will, I am sure, be the world-wide accepted principle of the future, particularly so in the Mechanical Engineering Industry. The beginner is taught the fundamental principles, a good general knowledge of metals, the correct use of tools, reading of working drawings, sequence of operations, and all the essential ground work is completely covered, before he is permitted to attempt to produce, and work on a production basis. Under such a system accurate and high quality is assured, and scrapped work reduced to a minimum.

3. A longer time is required to learn trades requiring considerable skill, and a longer preliminary education is required in preparation for Apprenticeship in some Trades than in others. All of these factors must be carefully considered and provided for. As too much preliminary education is not likely to be obtained every encouragement and inducement possible should be given towards a liberal education. In order to be successful, any method of Apprenticeship must endeavour to develop body, mind, character, and skill. The selection of Apprentices is of

great importance, and the Employer should carefully investigate the suitability of a candidate for the Trade that he wishes to learn. The investigation should take into consideration *Parentage, Character, Education and Physical Condition.*

There are no limitations to the creative and the enterprising in the field of Industrial Engineering; we live in an Engineering Age where there is great scope and opportunity for skilled labour to convert creative and ingenious thought and energy into useful work. The scarcity of skilled labour has in the past seriously handicapped the development of Engineering Industry in India, but this obstacle must be removed by throwing open to the Working Classes opportunities for Technical Training which in the past was beyond the reach of the average young man. Our Workshops require skilled and Disciplined labour, and we must see to it that our Training Schemes are developed on the right lines, and made attractive to the right type of youth. A reasonable living wage is of considerable importance, without which a serious obstacle would be put in the way of Competitive Selective Recruitment of the right types of youth of all Classes.

Education. It will be necessary to provide, at least for the first few years, the necessary Educational facilities as part of the Training Programme for such industrious youths who have the brains, but have not had the chance of attending a good school.

There are many cases where, due to financial or other circumstances, it was impossible for the Embryo Engineer to obtain a University Education, but the ambitious youth however need not be deterred, as many Engineers have started life similarly handicapped, and yet have proved eminently successful.

The youth with a good Secondary Education and who possesses a good knowledge of applied Mechanics and Electrical Science which constitutes the *essential equipment* of a young Budding Engineer, should have the facilities to continue his education in part-time Day and Evening Courses at a College of Technology, and where such a local Institution exists, as for instance—The Punjab College of Engineering and Technology at Moghalpura, this facility for attending part-time Day and Evening Classes should be made available at once. It would be of immense value particularly to the Punjabi youth, where at present the dormant Engineering instinct and lack of Engineering Science must remain undeveloped, and such latent ability must end only with the Practical side of the Engineering Trades.

There are many literate Artisans of outstanding ability in the Railway Workshops handicapped by lack of Technical Training, who would welcome such an opportunity even up to middle age to improve their general knowledge and earning capacity in Industry. There are undoubtedly many more in smaller Workshops in Lahore who would also welcome such an opportunity. It is not possible for the Local Education Authorities to effectively deal with Technical Education at

Continuation and Evening Classes due to lack of equipment and buildings, so that the full Potential Technical Resources of the Punjab cannot be exploited down to the Working Classes of the people, which is the source of recruitment for the young Trade Apprentices. These lads who possess a natural interest in machinery, must also be enriched by Technical Science in order to make them more useful to Industry. We must provide Education for the industrious youth who have not had the chance of attending a good school.

Practical Training. The Rules for the training of Apprentices for the Executive and Trade Grades on Indian State Railways and also of other Government or privately owned Factories will, it is suggested, require drastic revision. Under the specialised concentrated and individual system of Training, adopted by the Government of India Department of Labour and the Ministry of Labour in Britain which has been well tested and proved successful, the present five years course of Apprenticeship can be replaced by a well directed three years Workshop Course based on the principle of Specialisation. Apprentices for the Executive and Supervisory Grades in addition to Workshop Training, must have two years Technical training at an approved Technical College.

Experience has shown that although it is possible to produce under a concentrated individual system of training quite useful Artisans in a shorter period than three years, it has been found that the youths soon forget what they have been taught, and quickly lose " Touch " of the tools used in the Craft, unless they are continually kept up to their work. A longer period up to a maximum of three years is therefore recommended as an adequate training period for producing Technical Personnel and Craftsmen, superior in every respect to the general average of the past.

The Trade Apprenticeship Course should be strictly confined to one particular Trade, the aim being to produce a " Specialised Craftsman and Master of his Trade," and not a " Jack of all Trades."

It is, therefore, suggested that the principle of Indentured Apprenticeship should be adopted for Apprenticeship for the Trades, and the period fixed as three years', inclusive of the six months of the probationary period. The principle of up-grading must be applied, and this directional specialised and concentrated training would ensure a sound basic standard trade training common to all, and would produce a future group of efficient Artisans of a much higher standard than at present.

The Probationary and Trial Period. A Candidate should be taken on Trial and given every opportunity to demonstrate his fitness for the grade he has chosen, and also to determine for himself if the work is to his liking. A Trial period of two months would probably suffice in most cases.

All Apprentices irrespective of the Grades they have selected must be taught how to handle a hammer, chisel and file, and for this purpose

the first month of the training would be at the Fitting Bench. The importance of this Trial period should not be overlooked, as it is important for the Employer to secure Apprentices who will eventually make good efficient Mechanics, and also for the Apprentices to be in the Trade for which they have aptitude. One does not have to look far to find numerous instances of "Round Pegs in Square Holes."

During the Trial period, a record should be kept of the work performed, and the candidate for Apprenticeship should be under the direction of a Shop Instructor, as much as possible.

An opportunity should be given to each candidate to observe various phases of the work, in order that he may be able to determine his ability for the Trade he has chosen. This method, at the same time, enables the Employer to determine the suitability of the candidate. *There should be no compunction in discharging unsuitable candidates who do not display interest and keenness, during the Probationary period, it is an act of kindness rather than a hardship, for they are certain to prove failures.*

It is important that the Apprentice should come into contact with the real problems of the Shop, and that he should work as nearly as possible upon the same basis as the Workmen, knowing that the product which he contributes is part of the general product of the Plant. He should be taught to consider the commercial question of cost, and the problems of management in the Organisation, so that he may see where the Workman and Employer fit into the General Scheme. In Mental Training the same idea appears.

Apprentice Training Centre. In order to organise the Training of all Apprentices and raise the standard to that of a proper Indentured Apprenticeship, it is essential to provide an Apprentice Training Centre entirely apart from the manufacturing sections of the Works Organisation. This Centre would comprise Lecture Rooms, and Workshops fitted out in accordance with the prescribed Curriculum and Syllabus of Training for each Category under the supervision of an Apprentice Supervisor, assisted by Skilled Instructors.

Apprentices should commence a probationary period of six months' Training in the Grade or Trade they have chosen, and which has been accepted by the Apprenticeship Committee. If at any time within two months during the Probationary Period another Trade appears to be more attractive and congenial, the Apprentice should be at liberty to change the Trade on request, the period spent on the previous Trade would not count for the Period of Probation.

The Training Centre Workshops should be fitted out with complete equipment of every description including Lathes, Boring Mills, Milling Machines, Shaping Machines, Drilling Machines, Blacksmith Forges, Sheet Metal and Copper and Tinsmith Equipments Electric Arc and Acetylene Welding Plants, Electrical Apparatus, etc.

This System of Training constitutes an ideal way of initiating the young Apprentice who has come straight from School or College into the

life of a large Engineering Works, as he is able to visualise what his selected Grade or Trade covers.

On completion of the six months spent on the initial Probationary Period of Training, the Apprentices should be given work on a production basis, the Works Production Engineer distributing the work through the Apprentice Supervisor of the Centre as for the main Worshops, which would ensure that the work is carried out in the correct manner under expert supervision. By this method the training of each youth can be carefully watched at all stages and his value assessed. Work scrapped would also be reduced to a minimum.

Technical Lectures would be given for one hour daily in Lecture Rooms, and competition encouraged by giving credit marks for progress in general knowledge, conduct and interest in their work, which would be recorded in the weekly Progress Report. Each Apprentice would maintain a note-book containing full details of the lectures which would be checked by the Supervisor Instructor. In addition to the lectures given in the Lecture Rooms, Instructors would give lectures on the Workshop Floor explaining to the whole group, the reasons why the work in progress in the Shop should be tackled in the correct sequence of operations, in order to develop the training in accordance with the methods adopted for manufacture in modern Workshops where time keeps pace with quality.

At the conclusion of the Apprenticeship, the Management would be in a position to select the best type of Apprentice for their own requirements either for Supervisors or as *Skilled Improvers* in the Main Workshops of the Factory. The less efficient would be discharged or retained as semi-skilled workers, or may find suitable employment elsewhere, but such lads not selected for retention would have a good foundation training, and their future development would depend on their initiative and ambition to strike out for themselves, fortified with the knowledge that they possess a good Basic Training to earn a good Living Wage, and improve their earning capacity in the Engineering Industry.

Generally speaking, all Trade Apprentices would finish their full Course of Indentured Apprenticeship inclusive of Up-grading and Directional Training within the Training Centre, but in certain Trades it may be necessary to complete the Course in the Main Workshop, where facilities exist, which could not be made available in the Training Centre.

Bonus Scheme. A Bonus Scheme is recommended as an incentive to encourage all Apprentices to work diligently, and take an interest in their training. Such a Scheme produces healthy competition, and development of brain and body, and rewards apprentices who deserve recognition.

This Bonus to consist of two parts :—

(*a*) A Service Bonus depending on the Supervisors or Instructors' Reports which include ability, interest, progress time keeping and attendance at the Evening Continuation Classes at the Technical School during the month in

question. This Service Bonus to be divided into grants of say Rs. 2 per month, commencing at the end of the six months' probationary period.

No Bonus would be paid for any month for which an unsatisfactory Report has been given by the Apprentice Supervisor.

(*b*) A Supplementary Bonus or Annual Award on results obtained at the Evening Continuation Classes at the Technical School in order to encourage Technical Education. The award to be say Rs.20 for first place, and Rs.10 for second place in the Order of Merit.

Report and Record of Apprentices. The Report contains information on the following subjects :—

Interest, Application, Aptitude, Reliability, Confidence, Conduct, Accuracy, Speed, Knowledge of Works, Initiative and attendance, and with a space for any Special Remarks. If the Reports submitted during the Trial Period are satisfactory, the Apprenticeship Agreement between the Company and the Boy is signed.

The Supervision of the Apprenticeship Course would be in the hands of the Apprentice Supervisor, who would have charge of the entire Apprenticeship Course. Records of the performance of each Apprentice would be kept by the Employment Bureau, where he would be listed in the Regular Employment Card Index as an Employee, and also in a separate Card Index Covering all Apprentices. This Card Index would be used in connection with the Rand Visible Vertical File. Coloured celluloid riders would be placed at the lower right-hand corner of the Card, one month in advance of the date when the Apprentice is to be changed to the next Department. This gives time to prepare another Apprentice for the vacancy at the time of the change. A record will also be kept by the Class-room Instructor covering the details of the Apprentice Class-room work.

At the end of each six months, or at the end of each period in a Department, the Apprentice Supervisor makes a Written Report, to the Works Manager of the Company, giving completely and in detail his opinion of the Apprentices work and progress. The Employment Bureau will also keep a Card Index Record, which in addition to the information given by the Apprentice on his Application Blank, will contain data relating to when he actually started work, dates of transfer from Department to Department, etc. The Records of the Class-room Instructor will contain the marks obtained by the Apprentice in his various examinations and the record of his attendance. An attendance Record will also be kept by the Employment Bureau.

Apprenticeship Committee. The responsibility for controlling the Policy of the Management must be vested in an Apprenticeship Committee who must be carefully selected, and who are directly interested in the Training. This Apprenticeship Committee would guarantee

Continuity of Policy, recruit Specialised Apprentice Instructors, carefully select all Apprentices, direct their Courses of Training, and act in an Advisory Capacity throughout the entire period of their Apprenticeship. At the expiry of Apprenticeship, the Committee would advise the Works Manager as to whether the ex-Apprentice should be absorbed in the Permanent Establishment or not. The Apprentice Supervisor would act as Advisor to the Committee.

This Apprenticeship Committee would also organise amenities in the way of sports to keep the Apprentices physically fit, educational facilities, and organised Workshop Technical Lectures to develop the mind, and other attractions which would encourage Apprentices to take an interest in the Activities promoted and organised for their benefit during and after their working hours.

For the Critics. There are those who will say, " All this sounds very fine, but it costs too much money." Here is the crux of the whole matter ; these methods are not money wasters, but money earners. Many large and successful Concerns which have had Apprenticeship System in operation for a period of years, are unanimous in their statements that Apprenticeship Systems do pay. If properly instructed and intelligently directed, Apprentices pay for themselves as Producers during their term of service, as competent Junior Supervisors, or as skilled Improvers when they have completed their course, and as industrially intelligent Supervisors later on. The Apprentices who leave at the termination of their Apprenticeship become staunch supporters of the Shop where they were trained, always ready to say a good word for it.

These recommendations may sound theoretical and expensive, but experience has shown in Great Britain that it is Practical as well as economical. Tens of thousands of well trained Artisans have been produced in record time, the money spent in turning out efficient Workmen is a Guilt Edged Security rather than an Investment for any Industrial Undertaking. Unfortunately, facilities which exist in Great Britain are not at present always available in India, such as modern Workshops plant and machinery necessary for competitive large scale production of goods for the World Market, but Industries will definitely develop as soon as a better class of Supervisor and Workman is trained.

As already stated in this Paper, Industry is governed by the Law of Averages, the greater the productive capacity in terms of man-hours of each individual, the more useful he becomes to Industry. It is felt that the effort of all who have been interested in efficiently working the system of training adopted by the Labour Department of the Government of India will not have been in vain, if practical shape is given to the recommendations contained in this Paper to raise the past average standard in this country to that approximating Western standards.

In conclusion, I apologise for any repetition which may appear avoidable, but I trust that what I have stated will be found interesting to those who care to analyse the views put forward which are based on

experience gained by the writer, who has been interested in, and intimately connected with the Training of Electrical and Mechanical Apprentices in Railway Workshops for the past 21 years, and in organising, developing, and operating the N. W. Railway CIVMIL Scheme since its inception in March 1941 to date.

APPENDIX

A Description of the extension of training in Government Training Centres in Great Britain for up-grading semi-Skilled to fully Skilled Craftsmen.

Under the above Scheme the successful Government Trainee passes into Industry as a Semi-Skilled Workman, usually trained to the Improver's stage and consequently enters into employment at the Improver's rate of pay. In the limited time available the production of a fully Skilled Craftsman is not possible, neither is it attempted, but many of those emerging from their Training are well on the way to reaching a Fully-Skilled status and are able to pass the Trade Test after a further comparatively short period of Production Shop Experience.

The type of Training for this Up-grading is flexible to suit the various requirements of Employers in different areas, there are thus individual differences between one Centre and another, but they are all standardised to conform to certain proved Principles for training.

A very important aspect of the Scheme is the concurrent Theoretical Instruction the Trainees receive. For 15 minutes in each shift, work is stopped for a Lecture in which the Instructor deals with problems of the day, also explanations are given on subjects relevant to the stage reached in the Syllabus of Training. Blackboard notes and sketches are made and copied, every pupil having his own note-book, which is periodically inspected by one of the senior officers of the Centre. Enquiries are freely encouraged and answered, which invokes even the backward members to take an increasing interest in their work.

The discussions in the Daily Lecture period lead up to, or away from, the more complete Weekly Lecture, usually of one hour's duration, in which the general trend of training is dealt with. Usually held in a Lecture Room, the Trainees here receive regular reminders of the basic principles of the work and the opportunity is taken to satisfy the more inquiring minds and to enable the Trainees to compare notes.

From the foregoing remarks it will be appreciated, that Trainees must benefit extensively from this Balanced Instructions unless they find it impossible to absorb even the smallest amount of Mechanical knowledge. The whole atmosphere of training and instruction is progressive and the periodical practical tests develop the competitive instinct which accomplishes something more than the monetary gain accruing to the successful Trainee.

Before proceeding with a more detailed description of the Syllabus of Training as applied to the Major Trades taught in the Government Training Centres, a few words must be said about another very important branch of Training that of

The Up-grading of Labour

to perform operations of a higher grade after a shorter period of experience than would normally be considered necessary.

As the supply of Skilled Engineers has long been exhausted, Employers are having to look for the Skilled Labour they require from amongst their own Operatives and even at the expense of a temporary loss in production, experienced men in the Shops are being up-graded to the limit of their capabilities for which regularly systems of training are organised.

It is fully realised that all types will not be suitable for up-grading beyond the more simple operative tasks and that others reach their limits in varying higher degrees. For the executive to study the labour under his control with a view to taking advantage of any latent ability, will not only serve the urgent need of the moment, but will open up a line of interesting investigation.

Machine Operators

Turning and Boring. Trainees graduating from the Preliminary Course to Centre Lathe turning continue with more advanced practice in the Turning and Boring to standard gauges and micrometer, the use of the self-centring chuck and the setting up of work in an independent four-jaw chuck. The Exercise now set include the turning up of Lathe centres, processes involving turning, boring and recessing operations at one chucking, an introduction to Faceplate work and the method of Balancing, the cutting, of vee threads for which Trainees are taught how to work out their own change wheels, also taper turning operations using both slide rest and taper turning attachment.

As the Course progresses, Advanced Exercises in Face and Angle Plate work are undertaken, including marking out in the Lathe, instruction is given in the cutting of Acme and Square form threads and multiple start threads, both internal and external, the Trainees learning to grind correctly the various forms of Screwcutting tools required.

Towards the end of the course very useful experience is gained by operations necessary on repair work for other machines or equipment in the various Centres, the Trainees being required to select the best method of holding the work, and then to set up in Chuck or on Faceplate without assistance, and to use the Dial-Indicator and Surface Gauge to obtain running truth.

The feature of carrying out their own repair work by those under instruction, is but one phase of the Training Scheme Curriculum, which

in itself endeavours to cover the whole activities of a Manufacturing establishment without the necessity of recourse to outside assistance.

Wherever possible, Trainees finish their Centre Lathe Course on actual production work which takes the form of tools, gauges and equipment for internal use in the Centres or the actual manufacture of munitions components.

The Lectures throughout the Course naturally deal with the subjects appropriate to the stage reached. In addition, the Trainees receive a good grounding in Workshop Arithmetic, decimal equivalents and conversions, taper turning calculations and methods, screw threads and their characteristics, the Vernier, non-ferrous metals, alloys and compositions, and modern Workshop practice.

Before leaving the question of Centre Lathe turning, an interesting example of up-grading is described. At very short notice a munition Machine Operators' Syllabus was prepared, covering an eight weeks' course, for the purpose of Up-grading a Firm's employees—(who had previously been engaged on Cutting off Machines)—to the Centre Lathe operations involved in the manufacture of shell bodies. All the equipment was designed and made at the particular Centre including alterations to the saddle for the nose forming slide at the rear.

The first three weeks were devoted to general lathe manipulation, proceeded by two days of tools grinding, and including simple turning, first to caliper and rule measurements, then to the caliper gauge and length gauge measurements, with particular attention to parallelism and finish, and using round nose, right and left hand turning tools and facing tools.

During the fourth and fifth weeks the Trainees became accustomed to turning from former bars and learnt how to use grooving tools and to carry out their own tool setting, being now limited to plus or minus ·003″ on diameters, ·010″ on overall lengths and ·005″ on groove widths.

The Trainee is now able to undertake the turning of the body and forming the nose of the shell, the body being gripped and driven by an expanding fixture locating in the nose, and which comprises three inserts radically spaced round a loose sleeve which slides up a taper nose as the tailstock centre is tightened.

The forming of the body for the copper band is also carried out at this stage by means of the grooving tools.

In the sixth week, further experience is gained in grooving and undercutting, the Trainee then commencing the use of the special spring-loaded tool block located on the top slide and having a roller former, which bears against cam ring secured to the chuck, for the forming of the wavy band on the grooved portions previously machined for the copper band.

A further two days' tool grinding is included in the seventh week, during which week, limits on all operations must be reduced to plus or

minus ·002″ on diameters, ·005″ on overall lengths and ·003″ on groove widths, special attention being paid to wave line finishing; the final stage of threading the shell nose, is also completed.

The eighth week is a general revision of the Syllabus with special emphasis on machine care, tool grinding finish, tool setting and working limits.

Machine Operators

Capstan and Turret Lathes. To give an idea of the thoroughness in the training available in this important section, the Practical and Theoretical Syllabus including its developments as may be required in order to Up-Grade advanced trainees, is given, as follows :—

First Week. Practical—General operational working of the machines with special attention to the use and care of machines and equipment.

Theoretical—A General description of Capstan and Turret Lathes, including a comparison of the main features and details of the bar feed system and spring collects; the reading of drawings, etc., is also explained.

Second Week. Practical—Carrying out simple turning exercises using the tool post on the cross-slide and the parting-off tool; introduction to the dial index and cross slide stops.

Theoretical—Description and use of standard tooling equipment; how to read a micrometer.

Third Week. Practical—Carrying out plain turning exercise using the roller tool box; setting Capstan slide stops; and working to micrometer measurements.

Theoretical—Tool shapes and angles, the decimal system; the use of 3-jaw self-centring and 4-jaw independent chucks.

Fourth Week. Practical—Exercise in plain turning to limits with the roller steady box tool, radius end work, chamfering, and simple threading with the self-opening diehead.

Theoretical—Too coolants and lubricants; the pump feeding system; and a description of the self-opening diehead.

Fifth Week. Practical—Exercises in turning stepped components using roller steady tool boxes; the use of end facing and centring attachments; operations involving plain drilling, counterboring, recessing, and setting of Capstan and cross-slide stops.

Theoretical—Tool settings, with variations in diameter due to tool wear; general types of gauges and their use.

Sixth Week. Practical—Advanced exercises of a type similar to those in previous week introducing the use of snap and plug limit gauges; plain boring and reaming.

Theoretical—Detailed descriptions of drilling, boring, reaming, counterboring, recessing, tapping, knurling, etc., operations.

Seventh and Eighth Weeks. Practical—The production of representative components, requiring operations covered in previous weeks' training, to develop speed in production.

Theoretical—Speeds and feeds; screw thread systems, methods of cutting threads on Capstan Lathes, Vernier slide gauge, micrometer depth gauge and dial indicator.

Ninth Week. Practical—Exercise in drilling, counterboring and tapping with self-releasing holder, both open and dead-end holes; screw cutting with bottom dies releasing holder; chasing.

Theoretical—The metric system, incorporating metric micrometer and Vernier gauges; the various types of form and special tools.

Tenth Week. Practical—Exercises in 3 and 4-jaw chucking work involving the use of boring bar, reaming, counterboring, recessing, facing, forming, etc., in ferrous and non-ferrous metals.

Theoretical—Awkward chucking operations; grinding allowances; taper turning.

Eleventh Week. Practical—Advanced exercises using the full tooling equipment and setting all stops for fine limit finish.

Theoretical—the turret lathe, giving a comparison of the main features with the Capstan lathe; combination; a description of the tooling equipment, pilot bars, etc. also special fixtures.

Twelfth Week. Practical—Representative exercises to demonstrate the use of the turret lathe in comparison with Capstan lathe special attachments; pilot bars, adjustable reamers, taper turning, etc.

Theoretical—Speeds and feeds; Newall limit system, allowances and tolerances, etc. For the next four weeks development of the training is towards production at commericial speed of components requiring the full range of operations and tooling equipment, and working to close limits. The theoretical work during this period corresponds with the practical work and includes the preparation of lay-outs, elementary planning, sequence of operations, set-ups; elementary details of ferrous and non-ferrous metals, alloy and free-cutting steels, tool steels, heat-treatment, die and sand casting, etc., etc.

These Trainees are now available for transfer to manufacturing Workshops as Skilled Craftsmen and Machine Operators.

DISCUSSION

The **Author** in introducing this Paper said that he has prepared it at the request of Sir Arthur Griffin, the President of the Congress, and the General Manager of the North Western Railway to whom he was grateful for his guidance, not only in its preparation, but also for his support, inspiration and direction, in the development of the North Western Railway Civmil Training Scheme since its inception.

2. Since he wrote his Paper, he has seen and studied a Paper read by Dr. Flemming, a past President of the Institution of Electrical Engineers, covering a much wider scope of the subject than he has attempted. He recommended this Review prepared by the Education and Training and Personnel Sub Committee of the Institution of Electrical Engineers Post War Planning Committee in England, under the title, "A Critical Review of Education and Training," published in the I. E. E. Journal of September 1942, to those who are further interested in the problem, as the Paper he has contributed is confined only to a modern system of training artisans and technical personnel. The subject has also been discussed by the Institution of Mechanical Engineers and published in the Journal and Proceedings of October 1943.

3. Engineering industry requires a steady flow of skilled, disciplined labour, and in order to meet this demand, steps must be taken by the Post War Planning Committees in India to introduce, not only better standards of education as recently proposed by the Education Commissioner, but also well organised and efficient engineering technical training, schemes, adopting the most modern and advanced methods of training if the proposals for cheap rates of electrical energy followed by the industrialisation of India foreshadowed by Dr. Ambedkar, Member for Labour, in a recent address , are to materialise.

4. Success in any industrial undertaking is measured in terms of output commensurate with economy and quality, and this is in direct proportion to, and entirely governed by, the degree of skill attained, and maintained by its employees.

5. Industrial output is governed as far as its labour is concerned by the law of averages, *i.e.*, the average output of the average worker, based on a time study of the various operations. The greater the productive capacity in terms of man-hours of each individual, the more useful he becomes to his employer and industry.

If we accept the above theory as our basis for analysis and discussion, we may rightly ask the question how we are to acquire a higher standard of proficiency than exists at present in the workshops of India, which, at present, have a vast predominance of uneducated workers, and what steps are necessary to attain our object. The first essential is the immediate introduction of modern and efficient Engineering Technieal Training Schools for apprentices with State aid, if necessary, having a proper indentured system of apprenticeship, which aims at the development of

body, mind, character and skill. In this way, the social status of the artisans is raised, which attracts the right type of candidates for training in the various trade categories, and guarantees that after the apprenticeship period is completed, they possess the sealed and stamped parchment of indentured apprenticeship, a certified parchment to be proud of which admits the holder to the Engineering Industry as a bona fide fully trained craftsman, as distinct from a semi skilled worker.

Competition eliminates the inefficient, stimulates the average to do better, and rewards the able and efficient worker by the opportunity to show his usefulness and ability to demand a higher rate of wage commensurate with his output and ability to produce. The properly trained artisan possesses theoretical knowledge together with practical application, and it is this combination which really makes him valuable to industry. In fairness, therefore, to those youths who are to be the future source of supply of artisans and technical personnel of this country, the time is now opportune to increase the number of technical service training schemes designed for meeting the post-war requirements of industry, and working in close liaison with leading Engineering manufacturing concerns in order that the standard of training and the curriculum is in accordance with modern requirements.

Training schemes must be segregated as far as possible from factory production in order that the whole effort can be devoted to training. This however can only be accomplished in Government controlled factories, or in private enterprises of considerable magnitude.

7. Industry will require specialised and more highly skilled craftman in the future, masters of their trade, and not jacks of all trades as we find to-day.

Modern machines are efficient, but complicated, and designed as labour savers. The efficiency is judged by production in a similar manner as for man power, and has already displaced man power in certain classes of production work.

The machine, however, requires the assistance of the specialist both for its operation and maintenance, not the assistance of the handy man or the semi skilled, but of the highly specialised craftsman who can quickly make all the adjustments required for its maintenance and repair, in order that it shall continue to produce at maximum output. It is, therefore, the specialised workman who is required (whom we seek to produce) for the future requirements of industry, the type now rare and often impossible to obtain.

8. After the first stage of post-war re-construction has been accomplished, the control and distribution of skilled labour must be inevitably through the medium of Government Labour Bureaux and Employment Exchanges, and with this control, must follow the grading of all categories of labour and scales of pay based on the market values of each grade, in each District or Province. The educated and properly trained skilled worker who has successfully passed through the Govern-

ment Technical Service Training Schemes, or similar efficient and well directed schemes, organised by large Engineering Manufacturing Companies, Railways, etc., will have an enormous advantage over the uneducated skilled workers trained on the old and obsolete systems of the past. Uneducated labour will of necessity have to accept a lower grading and market value. Only by this policy will apprenticeship be attractive to the right type of recruits, which would ensure and guarantee that his future prospects and expectancy of receiving a good living wage is commensurate with his productive capacity and usefulness to industry, and at the same time enable him to maintain the social status that he is entitled to by virtue of the training.

9. Each country has its own peculiar difficulties and problems to face. He referred to one outstanding effort of modern times of common interest which is connected with the subject. The Russian Ural stronghold is a major factor in the present war. Light and heavy industry covering an area of some five hundred square miles out of reach of any possible enemy attack, has been built up during the past fifteen years by formerly unskilled workers who were trained as the work proceeded, supervised by a nucleus of skilled Engineers. This outstanding feat was only made possible by the foresight, leadership, and determination of the Great Russian Leaders in creating a Soviet intelligentsia, and training thousands of technicians by part time-release, and at night schools, whilst carrying on with their daily duties at the industrial plants, the State paying all costs of education. The graduation of wages, the increased difference between the wages paid to skilled and unskilled, educated and uneducated, stimulated the desire to study, and to bring expression and creative thought into being, each individual having the opportunity to improve his position and social status by his own personal effort. The result, as we all know, has surprised the world.

Mr. **D. A. Howell** said that he would like to compliment Mr. Adams on his Paper. He felt sure that the training scheme of the North Western Railway for craftsmen as described in the Paper will prove of great value, not only during the present war, but also as a permanent measure afterwards.

The question of training both craftsmen, as well as Engineers, has been receiving a good deal of attention from the Institution of Mechanical Engineers and the Institution of Electrical Engineers in England, recently, especially in view of the declared policy of the Government of that country to raise the age to which boys and girls must attend school, up to 16, which policy is bound to have repercussions on all industries. In what he had to say later, he would quote from what has been discussed by these Institutions as he felt that such opinions apply almost equally as well to India.

" The artisan or craftsman is the backbone, and also the foundation stone of engineering industry."—When he says this, he does not allude only to engineering manufacturing operations. He is just as essential in

the case of civil and constructional engineering, as he is in the case of mechanical and electrical engineering work. The first Engineers were often, craftsmen or artisans, who by dint of their special ability raised themselves to the status of Engineers. The most noted of these men whose name immediately springs to the mind is *Telford*, the Founder and one of the early Presidents of the mother of all engineering bodies i.e. the Institution of Civil Engineers. He was the son of a poor shepherd in a village in Scotland and he left the village school at the age of 13 to learn the trade of a stone mason.

Numerous examples of a similar character can be quoted,—too innumerable in fact to mention, but he would content himself with naming two. One was Murdock, a workman employed in the works of Messrs Boulton and Watt at Birmingham who about 1800, developed the practical application of gas-lighting, and was awarded the Rumford Gold Medal of the Royal Society for a Paper read by him on that subject in 1808.

As a recent example, the case can be quoted of Sir Henry Royce Bart, M.I.Mech. E., M.I.E.E., a poor boy who learnt a trade as fitter and who later on founded the firm of Rolls, Royce, the world famous designer and builder not only of the Rolls-Royce motor car, but the man responsible for the design and manufacture of internal combustion engines fitted into most of the British Aeroplanes used in this war, including the "Spitfire." He died in 1933 at the age of 70.

The facility by which artisans and craftsmen can work their way up to the top of the engineering profession has been termed in the Proceedings of the Institution of Mechanical Engineers as the "vertical mobility" of the profession. This "vertical mobility" has always been a dominant feature of engineering in Great Britain, especially in the case of the Mechanical Engineer who may be called the "Typical Engineer" standing midway between the Civil Engineer on the one hand, and the Electrical Engineer on the other. Before a body consisting mostly of civil or constructional Engineers, this claim that the mechanical engineer is really the "Typical Engineer" may sound heretical in this Congress, but that is only because India is a backward country so far as engineering industry in concerned. If India is to progress industrially, the day will no doubt come when the "Typical Engineer" in this country also will be admitted to be the Mechanical Engineer.

This "vertical mobility" in his opinion was what kept the engineering industry in Great Britain and the United States a living and highly progressive organisation, and attracts to it men of ability and brains. A clever and hardworking craftsman knows that he can aspire to the highest posts and honours in the profession. He can attain an Honours Degree in Engineering, and he can rise from the lowest ranks to the highest. In fact, every skilled worker has the opportunity to raise himself to the level for which his capacity and industry is fitted. Of course, there are difficulties, but these are not so great that they cannot be overcome by

a keen, able and hardworking craftsman if given the necessary opportunity, and there is an ever-increasing tendency especially in the mechanical and electrical engineering fields to make easier the path which the artisan or craftsman has to pursue in order to enter the ranks of the profession.

He thought that if India is to prosper as an industrial country, a similar course will have to be adopted in this country. The ranks of the engineers are now to all intents and purposes closed, in fact they have never been open to the craftsmen, except in very rare cases. We have now to make the conditions of entry into the profession gradually more elastic, and show the way to the clever craftsmen whereby he can better himself by the improvement of his general education, and the opening of day and evening technical schools where apprentices, craftsmen, tracers, draughtsmen, surveyors, and other workers in the engineering trades and industries can secure basic training in the theory underlying their work, at a very cheap cost to themselves. He did not mean to suggest that all this can be done in a year or even in ten years, it will take a long time, but he saw no reason why in 20 or 25 years, the condition and prospects of the craftsmen cannot be improved to bring him on the level equal to that of the craftsman in England today.

In England in the old days, the Mechanic's Institutes which were provided in almost every town enagaged in engineering or allied industries, did an enormous amount of good in giving part time, or evening instruction in engineering subjects. Later on these Institutes were superseded by the Technical Schools and Technical Colleges which fulfil similar functions, but on a much more advanced scale.

It was and still is, these part-time or evening technical classes which trained the men required in the industry such as foremen, draftsmen, assistant managers, and not infrequently, managers and engineers.

In the mining areas for example, only 25 years ago, more than 90 per cent of the Colliery Managers consisted of men who had worked their way up from the ranks by assiduous private study, and years of attendance at evening classes in mining subjects, thereby passing the qualifying examinations laid down in the Coal Mines Acts.

The same system applied to many other branches of engineering, especially on the mechanical and electrical engineering sides, steel and iron manufacture, etc., and there is no reason why the same kind of training arrangements cannot be introduced in this country with equal success. It is only by improving the standard of education, and training of the craftsmen, draftsmen and similar technical staff that the engineering industry as a whole can advance on a proper basis.

Mr. Adams has mentioned in his Paper, the training of engineers and higher grade technicians. In the old days in Great Britain, as well

as in the United States of America and other countries, the profession of an engineer was generally acquired by practical training and experience, coupled with such training in the theory underlying engineering practice as the aspirant had to acquire as best as he could in the absence of any Engineering Colleges, in the modern sense of the words. Usually, such training or pupilage extended over a period of about five years or longer. Very often the young engineers attended the local Mechanic's Institutes, or Technical classes, where craftsmen were taught in the evenings, while under going their practical training in the usual hours.

Later on with the opening of engineering Colleges, and the organisation of full time courses in engineering in the Universities since the last fifty years or so, a number of engineers have been trained thereby, but at the same time the old apprenticeship system, supplemented some-times by part-time, or whole-time study in technical schools and colleges has still continued to this day—in fact Wing-Commander T. R. Cave Brown, O.B.E., Member of the Council of the Institution of Mechanical engineers, in a Paper recently presented before that Institution on "Development of engineering education and technical training" said "It is possibly true to say that of the engineers who have "done well" in recent times, not more than one in seven has taken an engineering degree." Of this minority of say about 15 per cent who proceed to the Universities to study for engineering degrees, a considerable proportion do not obtain their practical training until after they have completed their theoretical engineering course, but some of the Scottish Universities have a Sandwich system in force whereby students do periods of practical work between periods of study.

The general consensus of technical opinion (*i. e.* of members or the Engineering Institutions who have recently considered the question) is that it is eminently desirable that the aspirant for the engineering profession must be put through a course of practical training in engineering works before he commenced his University course.

The advantages of such a system are manifold. In the first place it enables the candidate to secure practical knowledge of what "engineering" really consists of, in the initial stage. If he does not like it, he can get out of it at such an early age, that it will be easy for him to adopt some other more congenial profession. Again, the youth during his initial practical training will be at such an age, that he will more easily be able to associate with the work-men, gain their confidence and learn the practical work, use of tools, etc which is an important function of the work, without feeling self-conscious, or too superior to perform tasks of a menial character. He will also learn from the men their views on men and matters, which he will never be able to acquire at a more advanced age after passing through his College Course. This preliminary practical training which has been suggested should extend to between say one and two years, will also give the student a knowledge of the "technical jargon" of Engineering, and guide him with sufficient practical knowledge of the subjects which

he would study at the University, to make them much more interesing than they would be to one who had no knowledge of their practical application—. The young Engineer in such a case will enter the University at a more advanced age, when he will have discarded his boyish characteristics and become more serious-minded, having also had sufficient practical experience of the discipline of the workshops beforehand, instead of relegating this part of his training until he is much older, and probably unable to re-act quickly to the disciplinary requirements of his employment.

In regared to the actual teaching at the Universities, there is a feeling that so far as technical work is considered, this should be confined more generally to the theory of the subjects required for the profession, leaving the actual practice to be taught in the workshops and in or on engineering works, which is the proper place for such work, and not in the Universities where such practical work is liable to be not only out of place, but also out of date.

There is also a strong impression that teachers of engineering subjects at Colleges and Universities should not be divorced from the practical side of the profession, *i. e.* teachers should possess sufficient practical experience of engineering design and construction or manufacture, and should be kept in touch with recent practical developments, instead of working in water tight compartments.

Finally, it appears to be generally held, that apart from the teaching of engineering theory, engineering students should be given lessons in subjects tending to broaden their outlook and knowledge so as to fit them for their duties, not only as citizens, but also as leaders, developing their qualities of initiative, foresight and administrative capacity for the benefit not only of the engineering profession, but for general purposes. There appears to be an impression afoot that an engineers' training does not fit a man for general administrative work, whereas in fact however, the profession of engineering is such that it should qualify a man for such duties by reason of the experience which the engineer gains of the organisation on scientific lines of labour, and of large work of an industrial or engineering nature. You will find all over the world engineers in executive, as well as administrative control of Railways, Harbours, Transport organisations, mining companies, manufacturing concerns, etc. Why therefore should the engineer not be considered as fit to manage or administer Countries, States or Provinces ?

Is it because authorities consider that his basic training has been on too narrow a scale, and that he is a " mere technician " ? If so, then by all means let his engineering training be widened, and let him learn to write his reports in classical language, interspersing his technical language with Latin and Greek tags and quotations from classical literature and ancient History, and avoiding the commission of such deadly sins as split infinitives, if these qualifications be considered essential to a man for general administrative work.

Mr. **Hinton-Cooper** said that the **Author** was to be congratulated on his interesting Paper upon a subject which, although of great importance to Engineers, has not been given the attention and consideration the education of Apprentices deserves. The reason for this is not difficult to find. The Engineer-in-Charge of Works, the Foremen responsible to the Engineers for the outturn, the Chargeman responsible to the Foreman for the efficient working and maximum output from the Workmen, and the Workmen who are the men who produce that goods, are all too busy with the present, and productive work, to worry about the Apprentices and the future. The acquisition of practical knowledge and skill by Apprentices to provide the reliable Workmen and Supervisors for the future is hardly ever given a thought.

He felt that the Supervisory Staff and Workmen are not to be blamed, and that it is the system which is wrong. The Supervision Staff are not Instructors in the true sense of the term, but controllers of labour, and usually have not the patience to teach boys the fundamental use of tools, etc., and explain the why and the wherefore. Often they do not know the why and the wherefore themselves, and through ignorance permit bad practices, because in their youth they were left to pick up what they could as best they could, without proper instruction. Having succeeded in reaching the position they hold in the particular trade, they often have an exaggerated opinion of their abilities, and consider that what was good enough for them and their grandfathers, is good enough for the Apprentices of to-day.

He did not agree with Mr. **Adams** in his paragraph concerning the "Sandwich System" on page 4 where he says "the technical education only is the function of the College, and the practical training inclusive of the initial training in the use of tools, etc., is the function of the Railway Workshops." The proposed new system of training referred to by Mr. **Adams** in this paragraph was decided upon only after very careful consideration by the College Authorities, and the North Western Railway Administration. Apprentice Mechanics at the commencement of their training are young men, who have just left school and are looking forward to earning their own living as Artisans and Supervisors of Artisans. If the first 1½ years of their Apprenticeship has to be spent in the College purely for training on the technical side, then this would seem to them an extension of their schooling, and they would be inclined to lose interest. Boys who want to become Artisans are naturally impatient to start the practical side of their training. A boy has usually more interest in producing something himself, or in trying to do so, than to be eternally at his books, and the initial instruction in the use of tools in the College will therefore prove a healthy relief from a boy's studies. Also the Instructors will be selected men with ability to instruct and impart their skill. They will be selected by the Principal and Professors of the College who are themselves Instructors, and understand the type of man required and the difficulties of both Instructors and Pupils.

The new system of Apprenticeship includes another improvement of

considerable psychological value. On completion of the 1½ years in the College, the Apprentices will serve the remaining 3½ years of their Apprenticeship in the Railway Workshops as Workmen. They will be paid wages which imparts a sense of responsibility. The present system of giving a stipend and messing allowance to the Railway Nominess will be abolished, and instead, scholarships will be provided for by competition which will be current during the first 1½ years at the College. During the rest of their Apprenticeship they will receive their wages.

The Apprentices will, therefore, during their practical training be usefully employed on productive work. There will be occasions during their training when they may be employed on individual piece-work which will be an incentive to them to become more skilful, and when working on a gang on piece work there will be an incentive to the Chargeman, who participates in the piece-work profits of the gang, to help the Apprentice to increase his skill and output for the common good.

This second phase of the Apprenticeship is based upon the assumption that each boy on completion of his College training will have had such intensive instruction under close supervision in the use of tools in the College, that he is able to undertake any alloted task to the satisfaction of the Workshop Chargeman under whom he is placed. During the Workshop training the Apprentices will learn the construction of details, methods of manufacture, use of machines, etc., all of which is relatively simple, once a boy has acquired some mechanical sense and ability to use his hands. Therefore, to make the scheme a success, the College Authorities and the Punjab Government must provide adequate facilities and Instructors to impart this initial training efficiently. In our Civmil. Training Centre it has been proved that under intensive supervision, a raw boy from the fields can be turned into an expert toolmaker in a year, able to work to a degree of accuracy of ·0002".

The Turners are able to work to ·001", after only six months training. After only six months training boys aquire sufficient skill as either Fitters, or Machinists, to compare with the skill of any ordinary workman in an industrial concern. Of course, at this stage what they lack is experience and general mechanical knowledge—this they can only acquire later.

For those apprentices with ambition who wish to make a profession of engineering rather than remain tradesmen, opportunity would be given to attend evening classes at the College. The Principal of the College would arrange for this under the proposed new scheme.

Unfortunately the scheme has been shelved by the Punjab Government until the end of the war. Personally he considered this a mistake for now that it is definitely decided by both the College Authorities and the Railway Administration, that the existing system of training of Apprentices is defective, then the sooner it is changed the better for all concerned. This is of particular importance to the Punjab Government for the turning out of better trained men from the Railway Workshops

will materially assist in the successful industrialisation of the Province and improve its capacity to compete in the trade of the country.

Mr. **John Sargent**, Educational Adviser to the Government of India, congratulated Mr. **Adams** on having produced a very thoughtful and interesting Paper, and he stated that he had been particularly interested in the various comments that had been made by those taking part in the discussion.

Mr. **Sargent** then devoted his remarks mainly to the need for two types of technical training for post-war purposes. The first was to recondition the skilled or semi-skilled men who would have been trained under the Labour Department's Technical Training Scheme primarily for war purposes, and the second was the longer term process for evolving a system of technical education at its various stages, suited to the probable post-war requirements of the country.

The **President** said that the members would agree that the discussion on this Paper by Mr. **Adams** had reached a very high level, and they are very grateful indeed to Mr. John Sargent for coming to-day and giving them the benefit of his profound experience in the matter of training of technical personnel.

Mr. Sargent has mentioned both the long term and short term policies, but he would venture to suggest that they require something still shorter, something to cater for the immediate future. When he asked Mr. Adams to write this Paper, though he recognised that it would possibly deal with a very wide problem, he wished particularly to have put on record the extraordinarily good results which had been obtained from the system of training adopted in the Civmil Centre in Lahore. The evidence of what could be obtained by intensive and individual training and tution was outstanding. It reflected such a complete change from their own system in the past which has been condemned in the comments made by Mr. Cooper. Mr. Cooper was referring to the system of training we have of Railway Apprentices, which is carried out in co-operation with the Punjab College of Engineering and Technology. The previous system of allowing the Apprentices, after they have received their initial technical training in the College, to spend their time in the Workshops, possibly picking up incorrect methods, is rightly condemned. What is necessary is, that during the initial training in the College, the Apprentices should be brought into contact with the tools and the materials which they will use in actual work afterwards. This obviously demands adequate and modern equipment in the College. But it needs something more than that, as once the Apprentices go to the Workshops and receive their full practical training, it is necessary for them to be supervised and helped by staff specially set aside for this purpose. Unless this is done, the same objections which now rule will still apply. They have modern equipment in our Workshops, and he visualises that in a period varying from perhaps 5 to 10 years hence, there will be very much more modern equipment and machines introduced, and if they are to receive full benefit from this modern equipment, their artisans and their

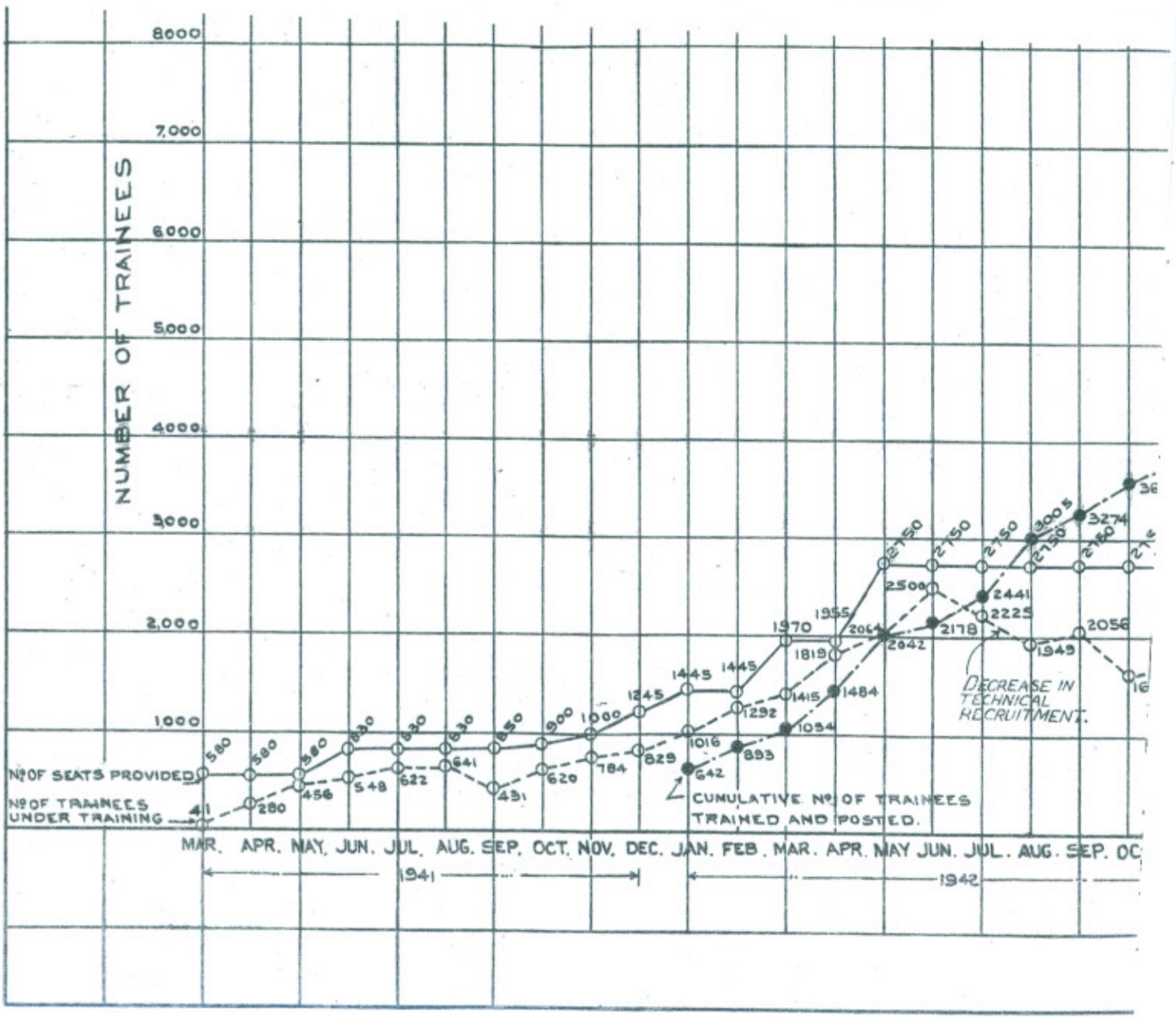
apprentices must be adequately and properly trained. If the technical schools envisaged by Mr. Sargent come into being, then undoubtedly the Railway would do all possible to co-operate with them.

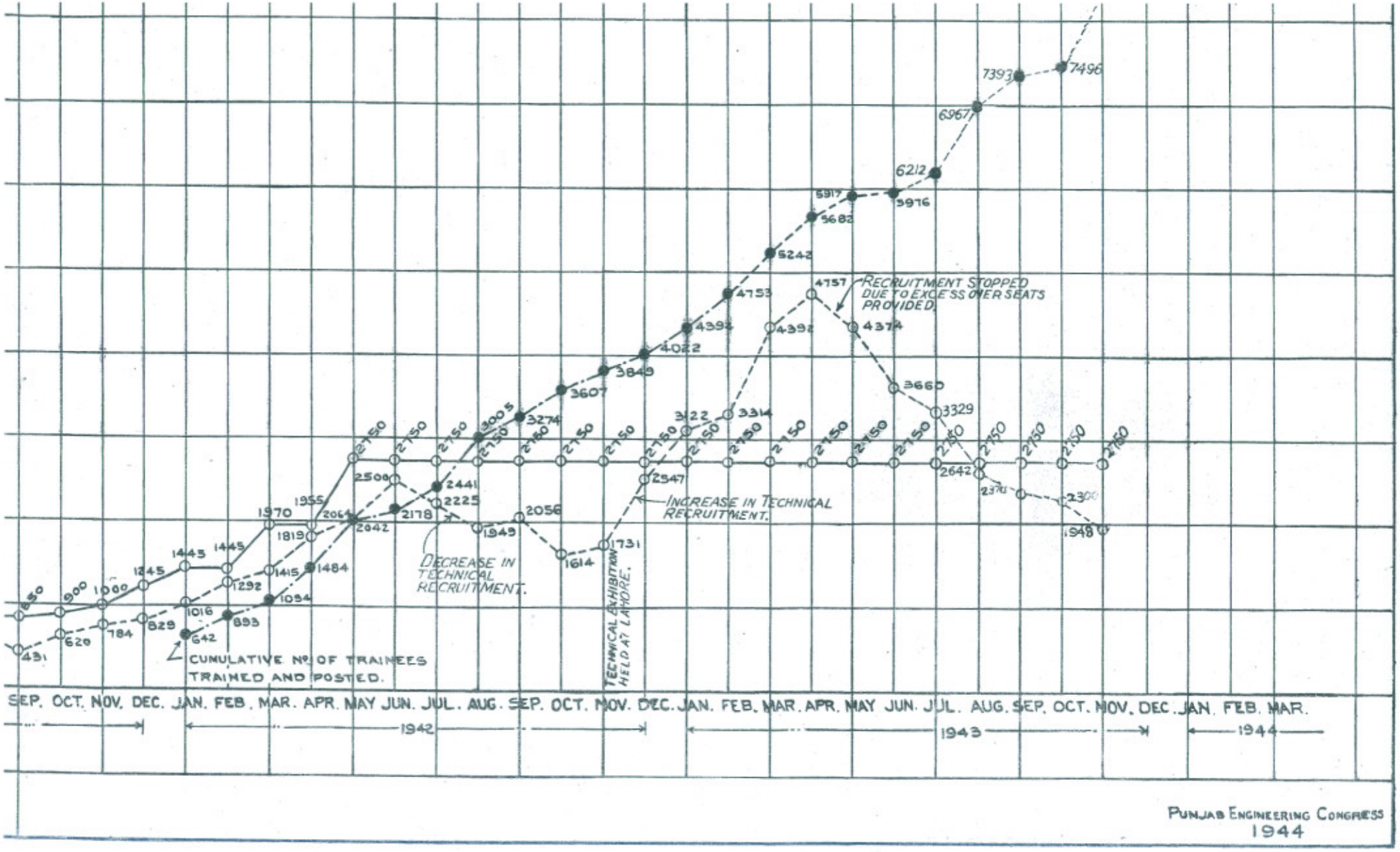
They should be grateful to Mr. Adams for having produced such a thoughtful and valuable Paper, and they are equally grateful to those who have taken part in this discussion.

Mr. **Adams** thanked the President and Messrs D. A. Howell, H. Hinton Cooper and J. Sargent for the compliments expressed by them during the discussion on his Paper.

He acknowledged that various modifications may be necessary in the system of training put forward by him to suit the requirements of the particular class of industry ; the same system could not be equally applied for light, as for heavy industry.

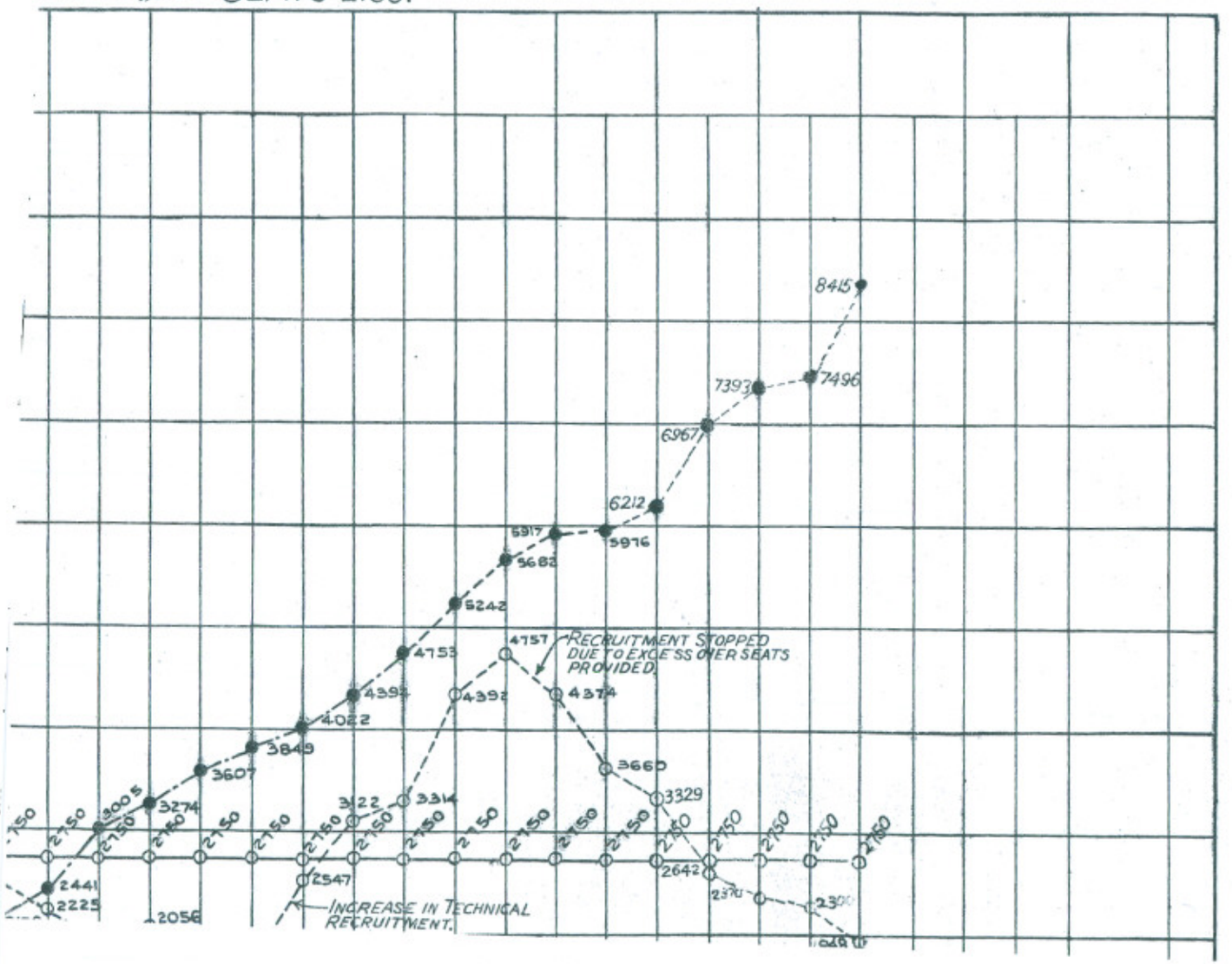
Technical schools may not be located in certain industrial areas and, in such cases, industry itself must provide its own apprentice training schools for giving its apprentices technical training within the Works' premises, during normal working hours by full or part-time day release, the management bearing all costs of the special technical training. There are many large Industrial Works in Britain and America which adopt this system which has proved particularly successful for the training of artizans, as it permits adequate time after working hours for recreation and sport, which are essential for physical fitness. It is also appreciated that only large Engineering Works would be able to satisfactorily undertake the training of apprentices to the standard of proficiency visualised as being the requirements of the future. The smaller concerns would, however, benefit in due course, as more skilled artisans became available after completion of their indentured apprenticeship.


NUMBER OF TRAINEES
8000
7000
6000
5000
4000
3000
2,000
1000
Nº OF SEATS PROVIDED
Nº OF TRAINEES UNDER TRAINING
CUMULATIVE Nº OF TRAINEES TRAINED AND POSTED.
DECREASE IN TECHNICAL RECRUITMENT.
MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OC
1941
1942

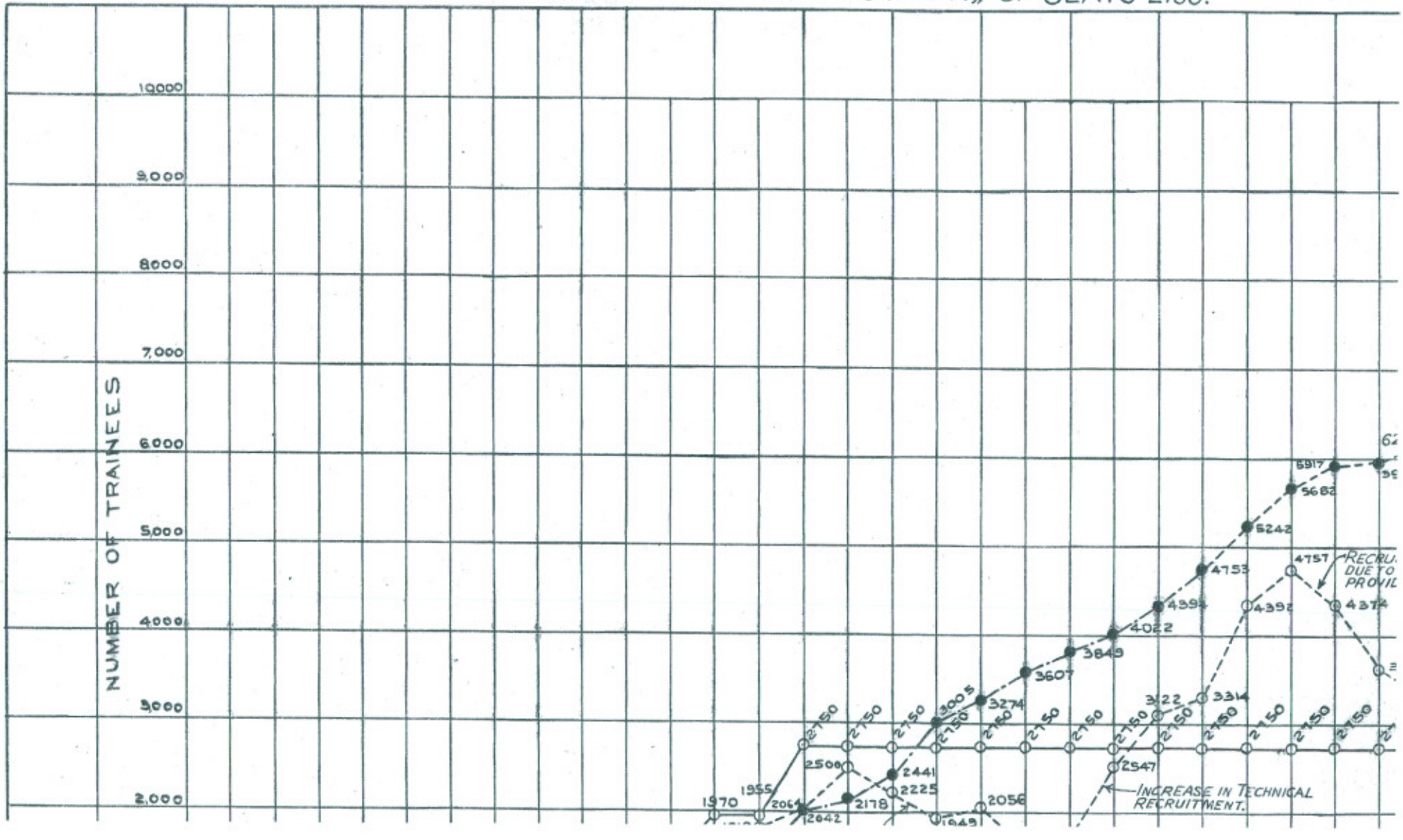

RECRUITMENT STOPPED DUE TO EXCESS OVER SEATS PROVIDED.
INCREASE IN TECHNICAL RECRUITMENT.
DECREASE IN TECHNICAL RECRUITMENT.
TECHNICAL EXHIBITION HELD AT LAHORE.
CUMULATIVE No. OF TRAINEES TRAINED AND POSTED.
SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR.
1942
1943
1944
PUNJAB ENGINEERING CONGRESS
1944

T: OF INDIA DEPARTMENT OF LABOUR
SCHEME N.W.RAILWAY CIVMIL CENTRE
IOP=2600, JHELUM BRIDGE WORKSHOP=150)
TAL Nos OF SEATS=2750.

PAPER No 266



PROGRESS OF THE GOVT: OF INDIA DEPARTMENT OF LAB
TECHNICAL TRAINING SCHEME N.W.RAILWAY CIVMIL C
(MOGHALPURA WORKSHOP=2600, JHELUM BRIDGE WORKSHO
TOTAL Nº OF SEATS=2750.



ERRATA TO PAPER No. 267.

Page 14 in line 10 from bottom, *read* 1937 for 1927.

Page 16 in line 6 from top *read* $Yo = Px\sqrt[4]{\frac{1}{64\,Elu}}3$ for the formula printed there.

Page 16 in line 11 at the end, *read* wood sleepers for wood sleeper.

Page 21 in sub-para (*d*) 1st line, *read* Ever for Even.

Page 30 in line 2, Section 5 (*ii*), *read* Re. 1-0-0 for 0-1-0.

Page 30 last line, Section 5 (*ii*), *read* Rs. 9-5-0 for Rs. 8-5-0.

Page 31 in Section 6 (*b*) (*ii*), *read* Rs. 8-2-0 for Rs. 3-2-0.

Page 35. An arrow pointing to the dotted vertical line in the section of sleeper should be added after the words "Limit to which the sleeper is packed."