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Sir Arthur Griffin, Kt., O.B.E., President,
Punjab Engineering Congress, 1944

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Punjab Engineering Congress

31st SESSION 1944

PRESIDENTIAL ADDRESS

Address of Sir Arthur Griffin, Kt., O.B.E., President, Punjab Engineering Congress, at the Annual General Meeting, on the 24th February, 1944.

1. It is my privilege to welcome on your behalf, to open this Congress, His Excellency the Governor of the Punjab. His Excellency, at some sacrifice of time and convenience, shows by his presence here this morning, his deep interest in our deliberations and in the progress of all engineering works in the Province. Our grateful thanks are due to him for the practical manner in which he shows that interest by honouring us with his presence at our annual functions.

2. We welcome also the Hon'ble Sir Manohar Lal, the Hon'ble Mian Abdul Haye, Mr. Savage, Mr. Sargent, Sir William Stampe and the other distinguished visitors who have done us the honour of being present to-day.

3. I desire also to express my appreciation of the honour done to me a year ago when you elected me as your President. I deeply appreciated this and I hoped that by my being President there might be an accretion to your membership from Railway Engineers. This has been fulfilled, and I trust that in the future Railway Engineers may be able to contribute more fully than they have done in the past to the proceedings of the Congress.

4. My particular duties have, for some years now, removed me largely from the direct practice of the Engineering profession and this I feel at times with no little regret. But certainly as General Manager of a Railway there is hardly a day passes when an engineering problem of some sort does not come before one. The practice in past presidential speeches seems normally to have been to expatiate on the year's progress of the Province and to make a review of the engineering activities of the past year. I propose, with your permission, to break away somewhat from this convention.

5. It is now ten years since a Railway officer had the honour of being President and I propose, as the theme of my address to you to-day, to make a survey of the various engineering developments and problems on Railways, mainly of course of my own Railway, during that time, and to glance into the future.

6. The Railway embraces within its own organisation practically every form of engineering. We have the purely Civil Engineer, the Mechanical, the Electrical Engineer ; and Signalling is now tending to become a profession of its own. With such a comprehensive field to cover, and as one is manifestly incapable of being an expert on all such varying professions, my review must largely be of a general nature ; but I trust I shall be able to make clear to you the importance of Railway engineering and the diversity of engineering interest which a Railway affords.

7. Take first the Civil side. Mr. Pavry, one time Chief Engineer of the N. W. Railway, in his presidential address to the Congress in 1931, mentioned briefly that in respect of track design, and of stresses in track, a theory which he termed revolutionary had been adopted. This theory, by no means new at that time, which has been universally adopted, broke away from the previous conception that the rail was a continuous beam on rigid supports with rail stresses calculated accordingly. The modern theory recognises that sleepers are not rigid supports, nor are they merely imperfect and irregular supports. It has been conclusively shown that sleepers are elastic supports and the problem is one of a continuous beam on closely spaced elastic supports. One must appreciate, therefore, that generally speaking the wheel itself runs on an horizontal path and the track comes down to meet it and rises again behind it. Looked at in another way, we have a continuous beam supported on rigid supports, *i.e.* the wheels, and loaded by a series of springs, the sleepers, pressed against the rail by the elastic ballast. The result is that the rail bends in a continuous curve between the wheels and not between the sleepers. The application of this theory involves the elastic modulus of the track, that is the number of force units per unit length of rail required to produce a uniform unit depression of the rail, and the determination of this requires a series of experiments on varying types of track, ballast and formation.

8. It is worthy of note that rail stresses calculated by this theory are higher than those calculated by considering the rail as a simple beam on fixed sleeper supports with the load placed centrally. Moreover a very striking fact is that the bending moment, and hence stress in the rail, is reduced with a number of relatively closely spaced wheels—there is relief of stress due to the proximity of other wheels. Therefore *weight for weight* the locomotive axles cause less stress in the rail than do wagon axles. Further developments of the theory were to allow for the other factors involved in a moving vehicle or locomotive. The stress in the rail is a sum of the stresses caused by the static load of the wheel, the speed, and the effects of the revolving and reciprocating parts of the loco. It is clear, therefore, that rail stresses can only be calculated for a locomotive when the design, and its peculiarities, are fully known. Mere axle-load is no sufficient criterion. Still further developments of the theory provided for the out of balance in wheels, curvature of track, the effect of joints in rails, etc. I mention this fundamental theory as, for one thing, further investigations were made a short time ago—as a matter of interest by two officers of the North Western Railway—and more needs to be done once conditions are appropriate. But there is a particular feature on which investigation and experiment is still relatively urgently necessary. I refer to the effect mentioned above of revolving and reciprocating parts of a locomotive and to what is termed hammer blow. The evil effects of hammer blow have been known for many years and bridge design in particular has been responsible for widespread investigation of the effects. The analysis of track stresses have shown that hammer blow is of equal importance in respect of permanent way.

9. Without going into detail, it will be commonly known that a locomotive is, what is termed, balanced, and that for two reasons. First to counteract the centrifugal force set up by the out of balance of crank-pins, connecting rods, etc., attached to the wheels. This normally should be complete balance. Then the second object, not universal and varying when applied, is to increase the above balance in an effort partially to counteract the effect of reciprocating masses—piston, piston-rod, etc.—this is termed overbalance. It is here that there is still controversy as these overbalances can, and do, cause considerable hammer blow. The practice on the North Western Railway with engines supplied since 1931, is that one-third overbalance for reciprocating parts is provided ; before that two-thirds was the practice. It has been demonstrated conclusively that excessive overbalance in the revolving wheels may at high speed actually result in the wheel lifting from the running rail with resultant severe hammer blow. With no overbalance an engine may have bad riding properties and transmit undue strain on the drawbar gear, and possibly cause increased wear and tear. There is a school of thought, which is being more widely supported, that overbalance might be omitted altogether, mainly on the grounds that the remedy may be worse than the disease, and this is influenced also by the fact that modern construction of reciprocating parts is lighter. This is a field for further research and experiment, and I hope that before long the time will be propitious to undertake this useful and interesting work.

10. Before I leave this subject I must touch upon the matter of the forces to which a locomotive is subject when running on the track, and this mainly concerns the problem of the flange forces and possibly track distortion which are caused by the moving vehicle. Those who are not directly interested must have taken notice of the many statements that were made in connection with the unfortunate Railway accident at Bihta on the E. I. Railway in July 1937. They will remember the frequent reference to engine "hunting", and the statements that excessive hunting on the part of a much maligned engine, type XB, was the cause of the accident. There was, and probably is still, some confusion of thought however as to what hunting really is. Briefly let me explain. There are five main movements of a locomotive and these are :—

(1) *Rolling*. A transverse oscillation of the engine on its springs about a horizontal centre line.

(2) *Nosing*. A transverse oscillation of the engine about a vertical axis.

(3) *Shuttling*. Oscillation fore and aft parallel to the track.

(4) *Pitching*. Front and back ends of the engine rising and falling about a transverse horizontal centre line.

and (5) *Hunting*. A combination of the *rolling* and *nosing* which rarely occur separately.

The shuttling oscillations act in a longitudinal direction and do not affect the immediate problem, but they are of importance in respect of the

problem of overbalancing I have already mentioned. And pitching has relatively little practical bearing.

It is the combined action called hunting which produces serious flange forces and which has received so much attention both by mathematical analysis, which actually has not proved of much practical value owing to the great complication of the equations deduced and the numerous assumptions which have to be applied to allow of integration and solution; and by practical experiment. In India both mathematical and practical investigation has been made, both before and after the Bihta accident, which itself drew pointed attention to the flange forces which may be induced by a moving locomotive. The important aspect of this phenomenon of hunting is that it is the result of the complementary effect of engine and track. All engines are liable to hunt to some degree, some are worse than others; but it is the combination of a sensitive engine, track irregularities and speed which may develop hunting to a serious extent and involve high flange forces. The endeavour must be to have the engine design such as to control hunting to the maximum degree, without at the same time inducing high flange forces, especially on curves, in the process of damping the amplitude of the oscillation, and to have the highest practicable standard of track design and maintenance so as to avoid those irregularities which of themselves may set up a hunting oscillation in the locomotive, or aggravate an existing oscillation.

11. I have dealt with this matter, necessarily in a very brief form only, but I wish also to mention that the research work carried out in India, again by the two officers of the North Western Railway, was outstanding in quality and comprehensiveness, equal to that carried out elsewhere in the Railway world. Indeed those officers were asked to carry out experiments with their apparatus on one of the English Railways. Indian Railways are not, you will observe, merely content to follow others, they may at times lead! Moreover, these officers designed and manufactured themselves the extremely complicated and delicate apparatus by which movements were recorded and flange forces, exerted on the rails by locomotives in motion, measured by electro-magnetic strain gauge recorders.

There is still much similar work to be done, and as an example of this I would remark that the recommendations made by the Committee which investigated the matter after the Bihta accident are now found not to be a complete and final solution to the difficulties.

12. In respect of development in recent years of the permanent way. The standard rails used by the North Western Railway are 90 lb, 75 lb and 60 lb. It is generally felt that these standard sections could be improved by a better distribution of the metal in the section, but this would involve alteration to all the rolls used in manufacture, and one can only look to the future for improvement. In respect of fishplates, there has been real improvement and the modern plate has greater strength to deal with the high momentary stresses of an alternating character which occur. Investigation into track stresses dealt particularly with joints and

fishplates. Constant attention is being paid to improving rail joints and possibly improved heat treatment of the fishplates will result in a more satisfactory fitting.

13. There has been a great improvement in recent years in the design of metal sleepers. There are, of course, diverse views as to the relative advantages both practical and economic of the three general types, trough, cast iron plate or pot, and wood, and at this Congress there is to be produced a paper dealing with the use of sleepers.

14. There has been a considerable advance in the design of crossings and switches. Heat treatment is being introduced and generally the designs are more substantial, with closer sleeper spacing and improved ties. Finally, track maintenance, which is of paramount importance and which has always been of particular interest to myself, has been placed on a better footing based on formulae taking account of several factors including the quantum of work involved in overhauling, and the types of track.

15. I must now make mention of the increased anxiety that is being caused to us (and here we share the anxiety with our Irrigation brother-engineers) by the trend of river regime, not only in the Punjab, but in Sind. It was only in 1942 that we suffered badly with breaches in the marginal bunds protecting the country from the river Indus. The main line to Karachi was for 10 days severed, and all Rail communication with Balauchistan was suspended for four months as part of the devastation caused by floods. In addition we sat on the brink of further calamity with an embayment of the Indus just north of Rohri bringing the river right alongside the main Railway bank, which had to be protected by heavily pitched aprons, on the Bell bund principle. I feel it is essential to stress the fundamental fact that a Railway embankment is *not* a bund. The Railway embankment is designed for the essential purpose of carrying Railway traffic and it is provided with water-way normally adequate to pass any anticipated flood or spill water which may approach. It is not there to protect the rest of the countryside from the ravages of flood—that must be met by some system of bunds or other protective measures.

In that particular locality we are adopting two safety measures. For some miles north east of Rohri the up and down main lines are being resited well away from the river at a total cost of Rs.64 lakhs; and a realignment north west of Rohri and Sukkur is being made which will take the Railway away from three Barrage canals which were breached last year, and in the direction from which potential floods might occur. This is likely to cost Rs.45 lakhs. This new bank will provide waterway adequate to pass floods of a magnitude previously experienced. This again emphasises the important point I have made of the Railway bank not being treated as a bund.

16. Elsewhere on the Railway in many places we have in the relatively recent past had to raise the Railway banks and provide additional bridging, and further work is about to be undertaken. Each

was at the time treated somewhat as a local problem, but it is evident now that all these works can, and should be, grouped into one comprehensive case. The beds of the rivers are rising and meandering is increasing, and the problem will have to be tackled with imagination and, above all, with courage, both professional and financial, by others than the Railway administration. What the eventual solution is I am not competent to say ; but whatever is decided will be of vital interest to the Railway. One thing I do hope for, and that is not to see in the Punjab a repetition of the failure of marginal bunds, as has occurred in Sind, if indeed it is eventually found necessary to have such a system of bunds at all. May be the solution will be found in controlling the peak floods in some way. But the worst feature, to my mind, of the marginal bund system is that when damage occurs, there has been almost invariably and perhaps inevitably a retirement, and in the process of time this has meant that the original system of bunds has disappeared and that the safety area between the marginal bund and what it is intended to protect—of which the Railway bank is really incidental—becomes less and less ; and then when further damage occurs, there is the threat of direct, and possibly sudden, attack. That is the precise reason why, as I have just said, we have found it necessary to realign the Railway over a length of many miles. We ourselves will have to think of our many major bridges, but the safeguarding of the countryside—and with that the main lines of the Railway—this safeguarding is a responsibility of the Punjab and Sind Governments, and in the efforts of their Irrigation Engineers we have both hope and confidence. Finance must, however, not be allowed to stand in the way—we have deplorable examples of this happening elsewhere in the world. I would appeal for the closest co-operation between the Railway and the Irrigation Engineer—and I feel that appeal will not be made in vain.

17. In bridge construction the North Western Railway can rightly claim a prominent place in the list of engineering achievements in this Province. Recent years have seen the regirdering and strengthening of some of the most important bridges on this Railway. The work on the Indus Bridge at Kotri, the Jumna Bridge at Delhi, the Victoria Bridge at Malakwal, and the Adamwahan are some only of the large projects completed. It will be appreciated also that such reconstruction work, carried out under traffic, presents many difficult and intricate problems, the successful overcoming of which is a high tribute to the skill of the officers and staff concerned. And speaking of bridges, though it has nothing to do with Railways, I feel it is unfortunate that greater public attention was not directed to the opening of the Howrah Bridge at Calcutta. The past year has seen the completion and opening of that bridge, India's greatest bridge, with a 1,500 feet cantilever span. This bridge is in the first dozen of the world's longest span bridges, and gives India the fourth longest span in the British Commonwealth of Nations ; the three longer ones being the Quebec Bridge in Canada, the famous Forth Bridge in Scotland, and the Sidney Arch in Australia.

I mention this also as it points a finger to a trend in future design of large steel truss bridges, where the dead weight of the structure is being reduced by the use of high tensile steel, having a strength almost 40 per cent greater than mild steel. In the future we may see greater attention being paid to the lightening of such structures.

18. Welding is playing an increasingly important part in all classes of structural engineering. Like most inventions which have displaced long established processes, the introduction of electric arc welding met, and apparently still meets, with a certain amount of opposition from conservative engineers, but the advantages of the new process are now being realised and welding has most certainly come to stay. Structures designed with the parts fused together by electric arc welding generally speaking show a considerable saving in weight ; but what is not always properly understood is that they must be designed from the very start as welded structures. It is here, perhaps, that some of the trouble has occurred in the past. Engineers brought up in the " riveting " school have had to accustom themselves to this new form of construction. Now that stage has been passed and the art of welding is itself making vast strides. I believe that experience in this war will teach us a lot and remove much of the previous bias against the new method. We have seen welded ships in increasing numbers, and from that alone much may be learnt.

19. Pre-stressing is also coming into the fore-front these days, both in reinforced concrete and in steel structures, and we adopted this method with the regirdering of the Victoria Bridge. Pre-stressing the members of a truss is the straining of the members and the inducing in them of stresses of an opposite nature to those occurring when the load is applied ; the maximum working stress will be less than it would have been had the member not been strained in the opposite direction initially. It has been claimed that an economy of five per cent has been obtained in certain members of large girders ; but, there are practical difficulties involved in the straining of the members and as yet it is very doubtful whether the saving in metal may not be offset by increased costs of fabrication.

20. I turn now to the mechanical side. In recent years great attention has been paid to the question of improving the standard of maintenance of locomotives and to providing modern equipment to ensure this. The engine sheds have been modernised and work in the Workshops has been systematised. But the exceptional advance in the standard of maintenance is primarily due to a change in organisation which introduced a system whereby trouble is anticipated in order to prevent out of course stoppages and repairs. This system is termed the Scheduling System. This introduces a series of repair schedules based upon mileage under which particular items, according to the rate of wear, etc., are examined, repaired or replaced as found necessary.

On completion of each mileage period (and each class of schedule has a mileage attached to it) certain specified items are attended to, no

matter whether they have given trouble or not. A comprehensive series of scheduling charts is maintained at all engine sheds on which is shown the position in respect of every engine—schedules carried out and when due. This serves also for planning ahead for repairs. Schedules on the average vary from Schedule A of something less than two days (mainly determined by the washout of the boiler) to Schedule F of about 15 days.

21. Owing largely to the nature of the country traversed by the North Western Railway the most prolific source of trouble was heated bearings, particularly of axle boxes. The causes of this have been under careful examination for a long time and as a result designs have been modified and other preventive measures taken. The result is satisfactory as will be appreciated from the fact that the average mileage per locomotive hot axle box has risen from 7,000 miles in 1939 to about 30,000 miles in 1943.

22. The period locomotives remain in service between general heavy repairs, which are carried out in the main workshops in Lahore, is governed by the boiler. Locos with new boilers usually complete 150,000 miles before shopping, after which they are certified for 100,000 miles, but this mileage is dependent on the water of the section in which the loco is working. This is the tender spot in our system. We have in certain sections, mainly between Lahore and Karachi, a type of water which is unequalled for badness pretty well anywhere in the world. The result of this is that the boiler shops in Lahore are the largest in the country and the volume of boiler repair the heaviest.

23. In order to overcome this very severe handicap to efficient and economical operation we have decided, after experiment, to instal a complete system of water conditioning between Karachi and Lahore and from Rohri to Sibi. We have adopted the base-exchange system which produces water of zero hardness, that is, water containing *no* scale forming materials. Very briefly, a base-exchange plant consists of a large drum which contains a material known as "Zeolites" a patented form of sodium alumina silicate. The water, after passing through a pressure filter, passes through this material and yields up its total content of lime and magnesia salts which are exchanged at once into a corresponding quantity of sodium salts. Periodical regeneration of the zeolites is necessary but this consists simply in rapidly passing a solution of common salt—sodium chloride—though the bed when the reverse action takes place. That is to say, the salt solution on its passage through gives up its sodium to the zeolites and absorbs from it the lime and magnesia which flow to waste. Special arrangements have to be made to prevent copper erosion, which was evident to some degree in our experiments, but we hope this will not now occur.

With the plants, the whole of the operation, regenerating, subsequent washing and setting for conditioned water, are automatically controlled both for time interval governed by the quantity of water passing through, and for time required for each operation.

These plants are now being installed and should be in operation this summer. The results we hope to obtain may be summarised as complete elimination of all scale, sludge and mud from the boilers. This should lead to clean boilers, elimination of washing out other than for fusible plug attention, no corrosion of steel enabling the latter to be used more generally for fire-boxes, and reduced boiler repairs. In general, this should result in more efficient operation and a saving in locomotive requirements with longer runs. I visualise in the future, passenger engine runs without no change between Lahore and Karachi, a run of 750 miles.

24. In order to meet the severe competition from road services, the Railway introduced a fleet of self-contained passenger units with Diesel electric traction. Unfortunately the units were of Continental make and at first gave trouble. They had to be withdrawn from service and considerable modifications made. Their subsequent performance, though perhaps subject to criticism in respect of the percentage of the units actually in service at any one time, has been outstanding. The service was reintroduced in October, 1940, and in three years a four car service ran 1,043,122 miles. The mileage per failure in traffic was no less than 173,854, and the cost per car mile progressively decreased to 12·567 annas, this being obtained despite the very large increase in cost of fuel-oil, lubricating oil, spare parts and wages. The mileage for service overhauls, originally fixed by the makers at about 20,000 miles, increased by stages to about 40,000.

25. I have little doubt that an extension of self-contained units will be necessary after the war, and I believe they will prove both economical and efficient provided a wise selection is made of both type and source of manufacture. Both straightforward Diesel engines, with fluid fly wheels, and Diesel-electric have proved eminently successful elsewhere. Of the former I might quote the case of those in use on the N. S. Railway. They have two 100 h. p. Gardner engines with fluid fly wheels and in four years have never had a failure. Their overhauls at 20,000 and 40,000 miles take a couple of days only, and at 60,000 a week. As I have said, a wise choice of type and manufacture is the main thing.

26. You are all aware of the great step in respect of comfort of travel which was made with the introduction of air-conditioned coaches. The system used by this Railway is the ice-activated, whereas that on the E. I. and G. I. P. is electro-mechanical. Those in use with us have given outstanding service with relative freedom from trouble, and I look—and I feel sure you support that—to an extension of these services in the future. We may see, in due course, all first-class coaches on important trains air-conditioned, and I would hope also to see such amenities extended for occasional services on important branch lines. Which system is to be used remains to be decided, but the initial cost of the ice-activated method is so very much less that, with properly organised arrangements for the supply of ice, it may hold the field.

27. For some years we pursued an active programme of electrifying stations. In an endeavour to assist generally, we extended our patronage

to many small local electric undertakings. In fact, it may be said that the Railway load enabled many of these small concerns to work at all. It is unfortunate that so many of them installed plant of foreign (mainly German) manufacture at probably low cost through subsidy. The result has been that owing to the type adopted and also due to the absence of spare parts and replacements, some of these concerns have had to close down. In the future, the Railway will either have to rely on its own plants or at least have to satisfy itself that the local concern is of suitable design before it places its load outside. This may be regrettable as the Railway administration is as anxious as anybody to see a wider extension of the great amenity of electric supply. We may, however, benefit from an expansion of hydro-electric schemes in the Punjab and other provinces.

28. In 1927 a Laboratory and Test House, equipped for carrying out chemical analyses and physical tests on material purchased by the Railway or manufactured in Railway workshops, was instituted, and it has justified its existence many times over, both in the matter of financial economy and in increased efficiency in the workshops. Regular tests are carried out on materials purchased for use on the Railway, ranging from steel bars and pig-iron to such things as paint, wheat, soap and glue. A regular check is also maintained on the alloys—cast iron, brasses and bronzes, antifriction metal, etc.—which are produced in hundreds of tons in the various foundries in the workshops, as well as on the process of manufacture (including heat treatment) of metal components. The Laboratory also handles many hundreds of water analyses every year for the Engineering and Medical Branches, besides undertaking the manufacture of such unusual and unexpected things as insecticide, liquid paint remover, foam solution for the Fire Brigade and synthetic seawater.

The Metallurgist and his staff also act as scientific consultants to the Railway in general and are liable to have all sorts of strange conundrums sprung on them. Typical examples are :— "How much mineral ash is there in fresh cowdung?" . . . . "Will our red oxide paint upset a mule's digestion?" . . . . And this one from the Claims Branch of the Railway, "The accompanying book has been damaged in transit; can you say whether the damage was caused by smoke leaking into a ship's hold, smoke from a Railway engine, or coal dust from storage in a dirty godown?"

29. Turning now to another matter. You may have seen an announcement in the Press in March last year briefly announcing the cessation of train services on the Railway between Bostan and Zardalu, a station 87 miles from Sibi up the Sind Pishin line to Quetta—known once as the Kandahar State Railway. With that announcement ended a romantic chapter of Railway development. It was in October, 1883, as a result of the Russian advance towards Afghanistan, that the construction of this line was begun. It was to be what they then called a heavy traffic line, and at the same time a light traffic line, partly on the narrow gauge was to be taken through the Bolan Pass, both destined to serve the Afghan frontier. Time does not permit of my mentioning some of the many

difficulties experienced in locating and constructing this broad gauge line through a chasm such as the Chappar Rift, but the work is generally acknowledged to have been both a bold conception and a remarkable achievement. I must just refer to the cause of the decision to do away with this line. On this line there is an area of clay and boulders about five miles in length, and this was termed Mudgorge by those constructing the line—a name which has persisted since. Between the mountains of limestone which form the valley there lies a thick bed of extremely unstable material. In this bed are large quantities of lime-sulphate compounds which, when exposed to the air, absorb moisture and swell, at the same time forming gypsum which, being partly soluble in water, causes still further trouble when the rain and floods come. Nothing worse could be imagined as a formation, and the history of the line from the beginning is a record of disasters with slips and other troubles. In recent years we attempted to divert the torrent through a partly artificial cut so as to keep it away from the Railway line. To do this a dam was constructed. The next year, floods of almost unprecedented volume came, the dam was breached and the bed of the gorge was deepened still further, so that slips occurred and the Railway was cut and tunnels were in imminent danger of collapsing into the valley. In view of the fact that there is the main line *via* the Bolan of very much greater capacity, and that immense sums have been paid to keep the Sind-Pishin line in existence and more would be required to repair the latest damage, and even then with doubtful results, I managed to persuade Government to agree to the abandonment of the line. It will be kept open from Sibi to Harnai, or even possibly to Sharigh or Khost, but, as a through line it disappears, and with it one of the great engineering achievements of that time.

30. You are all well aware of the strain that has been imposed on the Railway systems in India, and you will, from your own experience, well appreciate the difficulties there are in war time with so many closed markets in maintaining the Railway in a state to deal with the very greatly increased traffic. The immensity of the problem may be gauged from the fact that the stores purchases of the Railway, excluding coal, totalled 2½ crores in the last financial year. May I give you a few brief figures to indicate what this strain has been on the North Western Railway. Tons carried increased from 12,983,000 in 1939-40 to 16,499,000 in 1942-43, an increase of 27 per cent. Ton miles increased over the same period 41 per cent, and the number of passengers carried increased 42 per cent. Passenger train services, unfortunately, have had to be curtailed in order to economise in fuel, and the result of this, with the increase in passengers carried, is to be seen in the deplorable overcrowding, despite the fact that we have strengthened individual trains to the maximum extent possible by bringing into use all available coaching stock. We all regret the inconvenience which is caused both by this and by the equally aggravating epidemic there has been of thieving. The present market values of all metals and items of

common use have provided an irresistible urge to pilfer, and we have not been able to keep pace with the losses, or prevent them. It is no consolation, but it is of interest that we here are not alone in such trouble. Only the other day I read of the experiences of the Railways in England. Their efforts to improve train lighting with the blackout restrictions, have been seriously handicapped by the thefts of electric light bulbs and fittings. On the Southern Railway no less than 12,000 electric light bulbs had been stolen in the 6 months ending last September, and on another Railway over 16,000 bulbs had been stolen in the first six months of that year. They are also victims of losses by theft of many other types of fittings. Their problems, equally serious as ours, are, however, more easily remedied as we have very largely to import, and are even trying to do so by air.

31. This record would be incomplete without some reference to war activities. Unfortunately at this stage for obvious reasons one cannot mention details. At the beginning the Railway workshops had to fill in the gap of production until new plants were organised. At that time war production had, to an extent, to take precedence, now it is Railway maintenance which must receive priority. However, when the time comes, the statement of what this Railway has taken on and carried through, over and above dealing with traffic greater than ever before experienced and under difficult conditions, will make, I believe, an impressive array. The statement will include a very wide and varied list of many hundreds of items, some turned out in vast numbers - from extremely small and delicate portions of fuses, and from shells to ambulance trains (of which no less than six complete trains, and units amounting to another three, have been built, including such items as air-conditioned coaches and blood-transfusion cars) : pontoons, wireless masts and bayonets to curry combs enough to scratch the back of every animal in the Indian Army, etc. In the familiar journalistic manner, I would say that the shells manufactured would, end to end, stretch for a distance of 60 miles, and I leave you to do some rapid mental arithmetic as to the number involved.

32. Gentlemen, this is by no means an exhaustive (though doubtless exhausting) record of Railway engineering problems and progress ; but I apologise for taking up so much of your time, and thank you for the patience and attention you have shown me.

I will now ask His Excellency to address you and formally open this Congress.

SPEECH BY HIS EXCELLENCY SIR BERTRAND JAMES GLANCY, K.C.S.I., K.C.I.E., GOVERNOR OF THE PUNJAB

MR. PRESIDENT AND GENTLEMEN,

I am very grateful to you, Mr. President, for the kind welcome that you have given me on behalf of the Punjab Engineering Congress. It is a high honour for any layman to be present on such an occasion, but it is something of an ordeal for a layman to venture even a few words in a gathering of experts : however much he may admire the practical results of their labours and ingenuity, there is nothing of value which he can hope to contribute to their discussions ; he must content himself with a long-distance adoration and discreetly refrain from entering the arena where technicians cross their flashing swords. My diffidence has certainly not been set at rest by listening to Sir Arthur Griffin's learned address, a large proportion of which has, I must frankly admit, passed over my head beyond the range of my understanding. One item of information that Sir Arthur has given us has caused me no little disquietude—and that is his account of the strange variety of ways in which a railway-engine is capable of misconducting itself. It appears that even the best constructed and most perfectly behaved engine is obsessed by an incurable hunting instinct—romantic perhaps but nonetheless alarming. Like many others my highest ambition in my earliest youth was to rise to the position of an engine-driver. So far as I am concerned the last traces of this ambition have been finally dispelled. Those who would aspire to this calling require, I now realise, a quite unusual degree of resolution and gallantry : they must be prepared to force their uneasy iron hunters, snorting from flange trouble, over a flexible and elastic track in what may be described as a continuous "points to points" race from one end of the country to the other. So adventurous a career is beyond the endurance of the ordinary citizen.

Leaving parables aside, there is one thing that stands out very clearly from the President's address—the magnificent work that is being done in this period of strain by the Indian Railways and the North-Western Railway in particular. We know that they have sent many men overseas for railway work in and near the theatres of war. Materials for maintenance and replacement have been scarce while the demands of traffic have inordinately increased. War time requirements have imposed an almost impossible burden : the staff has been sadly depleted and those that remain have been called upon to turn out double or treble the normal quantity of bricks with the barest minimum of straw. In spite of all their difficulties, the Railways have carried on their business in the most meritorious manner and I am confident that you will join me in congratulating them and wishing them the best of success in the difficult times which are still ahead.

The engineers who serve the Punjab Government have also come successfully and with the greatest credit through another year of stress. Like the Railways, the Punjab Public Works Department has deputed engineers for essential undertakings in forward areas, while the vast amount of work that has been carried on in this Province by way of aerodrome construction and the building of strategic roads can only be made public when the War is ended. I should like those who are responsible for the rapid and efficient completion of these exacting projects to know that their labours are not the less appreciated because they have inevitably been denied publicity.

Perhaps I may be permitted, however to mention briefly some of the progress made in other directions during the year gone by. I would refer in the first place to the measures taken to grow more food. As soon as the " grow more food " campaign was set on foot, arrangements were made to run our irrigation channels to greatly increased capacity. Water was supplied to extensive areas which had never been irrigated before. The result has been a very material increase in the acreage under food-crops. Some of this increase was due to the reduction of the area under cotton and we were also helped by high prices and a favourable season, but the highest credit is also due to the engineering skill and careful organization of our irrigation engineers. I well know the anxiety and responsibility involved in cutting down the normal margins of safety and I am happy to think that the risks involved have been courageously and successfully taken.

The increased supply of water has also enabled us to make progress with land reclamation. Experience gained by the Irrigation Research Institute is now being applied on a wide scale and in the Northern Administration alone it is expected that 40,000 acres will be reclaimed each year.

In the field of construction we have seen the Western Jumna Extension almost completed during the last year and the irrigation already provided by the new channels has supplied us with a very substantial security-asset in helping to safeguard the South Eastern Punjab against famines in the future.

The Kalabagh Headworks which will serve the Thal Project are also approaching their final stage, and it has been decided to go ahead with the construction of at least a part of the system of channels. There are other schemes of construction, already sanctioned or actually in progress. I might mention in particular the conversion of the Burala Branch Extensions from non-perennial to perennial and the Tube-well Scheme on the Lower Chenab.

Our Public Health Engineers have almost completed a most interesting rural water supply scheme in the Hoshiarpur Siwaliks, the largest rural water supply scheme so far attempted in the Punjab.

This very brief review should be enough to show that Punjab Engineers have had a busy and a fruitful year. For the future there are

schemes already designed or outlined which will give as full scope for useful work and engineering skill as any of the great projects of the past. Some of these schemes are highly ambitious and in particular the High Dams projects in the Sirmur State and elsewhere, if carried to completion, will be among the largest of their kind in all the world. The importance of such projects transcends international boundaries and it is therefore most gratifying that we are receiving generous help from overseas. I would like to take this opportunity of offering the grateful thanks of the Punjab to the United States of America for sending to this country their foremost expert on such construction, Mr. John Savage, the Chief Designing Engineer of the United States Bureau of Reclamation. And we are deeply thankful to Mr. Savage himself for having undertaken the long and now-a-days devious journey from America to give us the benefit of his unique experience.

A very great share of the burden of post-war planning and reconstruction in India must fall on the engineering fraternity and in declaring this Congress open I will leave you to discussions which I am sure will play a most valuable part in laying the foundations of prosperity to come.