

Australia; the latter being a plant of a somewhat more elaborate nature. Before leaving the question of cranes, he wished to mention a few special appliances which are either examples of development along some special line of crane design, or are otherwise associated with crane work. The first is the use of Steam Shovels, or navvies, which may be considered as a development of the locomotive type of crane equipped with grab bucket. In the modified type the crane jib is equipped with a special boom to which at the outer end a bucket or scoop is attached. This combination of boom and scoop is operated by the crane in much the same manner as a long-handled shovel is used. These scoops are made to take out from $\frac{3}{4}$ of a cubic yard to 5 cubic yards at each traverse, and one of these larger machines will, if all goes well, handle as much as 4000 cubic yards in a 10-hour day. The reservation is necessary, since the variation in soil densities, etc., frequently leads to breakdowns.

One of our previous diagrams showed a coal truck tipping crane, and our next Plate XXV., Fig. 5, shows a special electrical appliance devised to carry out the same work in a somewhat quicker and simpler way, its method of operation being clearly shown. One can hardly leave the question of transporters and unloaders without at least mentioning the latest development in this respect, that is, the Hulett Automatic Unloader, Plate XXV., Figs. 5, 6, and 7. These machines have each handled over 500,000 tons of ore in one season, and it is claimed can unload 90 per cent. of an ore cargo without the aid of shovellers. The enormous capacity of these appliances is realised when one learns that the capacity of the unloading bucket is 10 tons, and that when open it covers an area 18 feet square. These machines cost close on £20,000 each to instal, and, when electrically operated, require the following power:—

An 80-horse motor to handle the bucket, a 150-horse motor for hoisting the walking beam, a 80-horse motor for trolleying in and out, and a 200-horse motor for moving the machine itself and the bucket car.

A valuable aid in hoisting operations is the electro-magnet, which has only recently been put to commercial uses. With these appliances a skilful operator can lower his electro-magnet on to a pile of plates and lift up six or more and then by turning his switch for a moment can drop the bottom plate, again turning on the current in time to prevent any of the rest of the plates from falling. The use of such an appliance as a labour and time saver must be very apparent, doing away with all hooks and slings and men to adjust them. The general design of these appliances is well shown in Plate XXV., Figs. 8 and 9.

With the enormously extending use of cranes and lifting appliances in workshop operation, one finds associated many other labour and time saving devices and methods, such, for instance, as that shown in Plate XXVI., Fig. 1, of the machining of the stator frame of a large alternator. In this you will note that the various machine tools, each electrically or pneumatically driven, are lifted and planted onto the work where required, thus enabling several machine operations to be carried out simultaneously.

We now come to the second class of intermittent handling appliances, namely, Aerial Ropeways. This, one of the most ancient of known labour saving devices, and primarily consists of a rope stretched between two points and carry trolleys, from which buckets are suspended, these trolleys being travelled by either an independent rope, or by their being clipped to the carrying rope, which in such cases is made to travel.

The system of wire rope transport now in practical operation may be classed under the three following headings:—

- (1) Those which employ an endless running rope with carriers hanging therefrom and either attached thereto permanently and at a fixed distance apart, or gripped by frictional contact, in which latter case the carriers are provided with rollers so that when the friction grip is released, the rope travels free with the carrier stationary.
- (2) Those which employ either one or two fixed ropes which act merely as a rail or rails upon which carriers are drawn along by means of an endless hauling rope.
- (3) In some instances where the conditions are suitable, a single fixed rope is placed on an incline, on which carriers are allowed to run at a high speed, and entirely uncontrolled by any hauling rope. The application of this third system is so limited that we shall only consider those examples which come under the first two headings.

The endless rope system is undoubtedly the simplest, and its possibilities have been greatly developed during the past few years, as may clearly be realised from Plate XXVI., Fig. 2, which shows in profile a section of country over which such a line has been working for some few years. The length of this line is nearly 13,000 feet, two of the clear spans being close on 2000 feet, and over it some 50 tons per day are handled in net loads of 2cwt. Plate XXVI., Fig. 3, shows a typical trestle, and well illustrates the class of country where these ropeways are installed, the ruggedness of which would render transport in any other way extremely costly and laborious. Plate XXVI., Fig. 4, shows the

driving terminal station of a similar line, having a capacity for 200 tons per day. The method of rope drive and discharge into railway trucks is clearly shown. Plate XXVI., Fig. 5, shows a group of nine such ropeways arranged in groups of three, the whole being capable of handling 2500 tons of iron ore per day. This arrangement, whilst appearing complex, has one great advantage, that a breakdown of any one or two lines only slightly interferes with the general operation of the system. When the individual loads to be handled exceed 5 or 6 cwts. it has been found desirable to adopt the 2nd class of ropeway, that is, those with fixed main rope and independent endless hauling rope. This arrangement is clearly shown in Plate XXVI., Fig. 6, which illustrates a trestle on an Alpine ropeway, the clear span on each side of the trestles being over 3000 feet. In this diagram the carrying ropes and trolley and load can clearly be seen, and also the hauling ropes, one of which is resting in the special guide sheave, the other being lifted out of its sheave by the passing load. Plate XXVI., Fig. 7 shows the out end terminal station on a similar ropeway, carrying half ton net loads on a 1 in 6 incline, the clear span shown being over 2100 feet. One of the main advantages of aerial ropeway systems lies in the simplicity of the appliance required, much of which can in most situations be supplied and repaired locally, and without highly skilled labour. This is well illustrated in Plate XXVI., Fig. 8, of a ropeway installed in the forest country in India for the transport of timber from the upper forests to the main roads. Prior to the installation of this ropeway, elephants were used for hauling the timber over the rough roads during such periods of the year as they were not rendered impassable by the heavy tropical rains. The trestles were all constructed of rough round timber erected by native labour, the highest being 75 feet in height. There are six spans in

the length, the greatest being over 1650 feet, and the net loads carried frequently exceed 1400lbs., exclusive of the weight of the carriage. Plate XXVI., Fig. 9, shows the simplicity of the rope hangers.

An extremely interesting plant has recently been installed by an English firm for the handling of ore, and the general loading and unloading of vessels in New Caledonia. This plant has been put down to avoid the construction of long, deep water jetties, etc., and is so arranged that everything, including passengers, passing to and from the larger ships trading at this port, are handled by it. It consists, as shown in Plate XXVII., Fig. 1, of a special landing stage erected in deep water, and connected to the shore by an aerial ropeway, over which all the loads, live and otherwise, are transported. The landing stage is equipped with modern cantilever type loading and unloading machines, two of which operating at one time upon a vessel's cargo can together handle 200 tons per hour (Plate XXVII., Fig. 2). The ropeway has a capacity of 100 tons per hour each way, and the benefit of these facilities can well be realised when one learns that a 3000 ton vessel, which formerly took an average of 40 days to load, can now be loaded in from two to three days.

Cable Railways consist essentially of an endless steel cable provided with guides, curve and supporting sheaves, and "take up," and driven by a suitable steam or electric driving mechanism. This line runs above or at the side of a suitable trolley road, upon which cars are run, these being driven by friction grips on the travelling cables. Two main systems are in use, the "Continuous," in which several cars are gripped to the rope at intervals of 50 feet or more, the cars having a capacity of from 2 to 5 tons each, and the rope travelling at from 200 to 300 feet per minute, This system is

used where the amount to be handled exceeds 50 tons per hour, and is well shown in Plate XXVII., Fig. 3.

The other system is known as the reversible or shuttle type, and in this type two cars and two trucks are employed, the loading one travelling in one direction, whilst the empty one is at the same time being returned to the loading point. Such a road is shown in Plate XXVII., Fig. 4.

Before leaving the question of Cable Railways, one might mention the use of power-driven capstans, which are now frequently installed for wharf and jetty work, the usual traction capacity lying between 2000 and 4000 lbs., at a speed of about 120 feet per minute, the maximum speed being governed by the rate at which one man can handle the rope off the barrel. They are usually either electrically or hydraulically operated, and are pedal controlled, thus enabling one man to operate the capstan and handle the rope. A typical turnover pattern hydraulic capstan is shown in Plate XXVII., Fig. 5. The turnover arrangement is convenient for inspection and repairs.

Travelling hoists are now one of the commonest and most economical methods of handling material in the factory. In its simplest form such a system consists of a suitably supported beam or track carrying a trolley carriage, from which the load is suspended by chain block, or special power operated winch. In the first installations the travelling was hand-operated, but in modern electrical equipments this is also power driven, and by the addition of a second trolley carrying a suitable frame and cage the operator has always thorough control of his load and travels with it. A typical modern trolley equipment is shown in Plate XXVII., Fig. 6, the runway, as is usual, being formed of rolled steel beams, with the trolley wheels running on the top side of the lower flange. Plate XXVII., Fig. 7, shows a typical

hoist runway with switches, turnouts, and crossings, and Plate XXVII., Figs. 8 and 9, show typical installations—the one for outdoor work, the other inside a building. Such a system may be laid out to cover a large area of floor space, or used for transport over long distances and difficult or obstructed ground. Hoisting speeds vary from 30 to 60 feet per minute, and travelling speeds from 120 to 250 feet per minute.

We now come to the two last items of an already over-lengthy paper. Elevators used for intermittent service are familiar to all of us, some of the installations in this city being highly efficient and up-to-date. Plate XXVII., Figs. 1 and 2, show typical examples of the modern elevator, the one electrically and the other hydraulically operated, and before leaving this question, he thought it would be of interest to show two diagrams of the Escalator, or moving stairway, which in America now rivals the lift for certain purposes (Plate XXVIII., Figs. 3 and 4). These diagrams had been kindly lent to him by Mr. Bainton, and showed clearly the operation of this appliance, and its outside appearance. It possesses the interesting advantage over an Elevator that a man in a hurry can run up the moving stairways, thus possibly doubling his speed, but the resultant sudden landing on the fixed floor must be somewhat peculiar.

Plate XXVIII., Fig. 6, shows the application of a special elevator for wool bales as installed in a leading Adelaide warehouse by the Jeffry Company. This machine, which consists of two endless chains with suitable projections to engage the bales, is capable of handling 200 bales per hour.

The question of Industrial Railways is one of considerable importance, although time will not permit of us to consider it, but bearing in your mind some of his earlier illustrations which showed women and boys hauling coal in the British mines not 60 years ago, compare

them with the methods illustrated in diagrams, Plate XXVIII., Figs. 6 and 7, which show typical rack and adhesion electric mining locomotives. Such a locomotive is clearly shown in Plate XXVIII., Fig. 8, and a further idea of the spread of labour-saving devices in this industry is shown in Plate XXVIII., Fig. 9, which illustrates a modern coal cutting machine at work.

He had now come to the conclusion of what he feared had been an overlong paper, but the subject is one of such vast importance to us here in Australia, with our unhappy industrial conditions on the one hand, and the high rate of wages for labour on the other, that he must be excused for having so greatly trespassed upon your time.

He had endeavoured to set before you as briefly and concisely as possible, firstly, a hurried picture of the workers' condition a century ago (before the introduction of labour-saving machinery), and, secondly, the present state of affairs, as witnessed by the magnificent appliances now available in but one branch of the world's work.

Comparisons of the general conditions of the various civilised communities sixty years ago and now, must demonstrate that there has been a progressive improvement, and that the standard of living has been raised. If the spirit of unrest has increased it is because the people have learned to want more because it has chiefly through the introduction of machinery become possible for them to have more. To say that there are just as many naked, starving, and hopeless people as ever, is no answer to those who assert that the machine has enormously raised the standard of material comfort for the people. The man who has no penny is always with us, but the machine has not made any more of him. It has enabled the man with a penny to get for his penny a bigger or a better something every time. If the

machine therefore gives us a better pennyworth without diminishing our opportunities of getting pennies, the machine must be a benefit..

In conclusion, he would quote from a lecture given by Daniel Webster as far back as the year 1828, in which, commenting upon the progress of the mechanical arts, he says:—

“Machinery is made to perform what has formerly been the toil of human hands, to an extent that astonishes the most sanguine, with a degree of power to which no number of human arms is equal, and with such precision and exactness as almost to suggest the motion of reason and intelligence in the machines themselves.

“It is on the rivers, it is on the highways, and exerts itself along the courses of land conveyance; it is at the bottom of mines, it is in the mill and in the workshops of the trades. It excavates, it carries, it draws, it lifts. It seems to say to man: ‘Leave off your manual labour, give over your bodily toil; bestow but your skill and reason to the direction of my power, and I will bear the toil.’ ”

