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LABOUR-SAVING DEVICES.

By G. A. JULIUS, B.Sc., M.E.

INTRODUCTION.

The subject which the author has chosen for this paper is one of considerable magnitude—embracing as it does operations in all classes of work—and he proposes, therefore, after briefly considering the demands for the general application of labour-saving appliances and the effect of such application, to more closely, and in more detail, discuss the special operation of such devices in the handling and transport of materials, the latter problem being one which more intimately concerns us here in Australia than does the question of the use of special labour-saving tools and machinery as adopted in various manufacturing processes.

It is an inherent quality of the human mind to seek the lightening of whatever manual labour environments of life may require. This has been manifested in all ages, the discovered relics of prehistoric man point to the same fact. One might with interest follow the development of machinery through the ages, from those far-back times when but the simple lever and such elementary mechanical appliances were known, and probably used in the building of Egypt's ancient temples, down to the latter end of the eighteenth (18th) century, when, from the introduction of the steam engine, arose revolutionary developments in the application of machinery to all classes of work.

Such a discussion, however, whilst, no doubt, of interest, would require a considerably greater time than we have at our disposal; and, beyond a few illustrations to emphasise the advance made in certain classes of work, it will not again be referred to in the paper. Naturally, the industries to which the thought of Engineers were early directed in the possible application of machinery was that of coal-mining, since, although such mining has been carried on in Great Britain from the thirteenth (13th) century, the depth and extent of the workings were greatly limited by the presence of water, insufficiency of air and the great labour required in raising the coal to the surface.

During the early part of the tenth (10th) century, attempts were made to raise water in several stages by chain pumps operated by water-wheels in the manner illustrated in Plate XIX., Fig. 1; and whim gins worked by horses were substituted for the manually-operated jack-rolls in the raising of coal, the latter, however, remaining in general use until the middle of the nineteenth (19th) century.

It is interesting to note, from the report of the Royal Commission in 1842, that women were then employed in many parts of Scotland in carrying the coal up the shaft in baskets. Similarly, boys and women were engaged in the haulage of the coal in the workings up to about the middle of the eighteenth (18th) century—the coal being placed in baskets and mounted on a form of sled, as shown in Plate XIX., Fig. 2. It is to be noticed, however, that by the beginning of the nineteenth (19th) century the sleds had been equipped with wheels (Plate XIX., Fig. 3), thus materially lessening the labour of hauling, and, in this work, women and girls were employed up to the year 1843.

The difficulties encountered in the ventilation of the mine workings were also for some time insurmountable, workings being abandoned as soon as foul air became unbearable. Early attempts were made to overcome this trouble (as shown in Plate XIX., Fig. 4), although the efficiency of such an appliance must have been very low and the risk attending to its use being correspondingly great, unless the labourer in those days stuck more consistently to his work than is the rule nowadays. But, no doubt, an unauthorised stoppage on the part of the human motor would have been attended by fatal results to himself, as well as, possibly, to the underground workers.

It may be mentioned in passing that, up to the middle of the eighteenth (18th) century, colliers were worked under laws by which they were practically slaves; able-bodied men were paid tenpence per day for hewing coal, the women acting as bearers in carrying the coal out of the workings, and receiving but threepence per day. One wonders whether the risks attending this latter occupation were adequately met by the remuneration, if our next illustration (Plate XIX., Fig. 5), which is taken from the report of the Royal Commission of 1842, is a true picture.

The invention of the atmospheric engine by Newcomen in 1710, and the first use of gunpowder in British coal mines in 1719, enabled more difficult mining operations to be undertaken, changing, in fact, the whole aspect of the industry. The first steam engine was erected in 1712 for pumping (Plate XIX., Fig. 6), and from this date the application of steam for this purpose was steadily extended, a pumping engine being erected in 1763, having a steam cylinder 6 feet in diameter and 10 feet 6 inches long. In 1870, the first engine was applied for drawing coal, of the atmospheric (Newcomen's) type, and the first Boulton and Watt closed top cylinder engine was erected in 1790. Some of these antiquated and interesting old engines are still to be seen at work in South Staffordshire, whilst many others have only been put out of commission during the past few years. A few typical examples are shown in Plate XIX., Figs. 7, 8, and 9; Plate XX., Fig. 1. Horses also were largely introduced in the mine workings to replace the haulage by boys and women, and are still in use in many collieries, although one of the difficulties attending their use is well shown in this view (Plate XX., Fig. 2).

A typical up-to-date British colliery of the year 1816 is Plate XX., Fig. 3, and was, he believed, equipped with low-pressure spherical-top boilers and Watt engine. Two other illustrations of considerable interest, and which no doubt many of those present would recognise (Plate XX., Figs. 4 and 5), showed the head gear and pumping arrangements used in the construction of the Kilsby Tunnel in the London and North-Western Railroad in the year 1835. The pumps averaged 1800 gallons per minute, and were driven by bell crank and transmission rods in the manner shown. As would be noticed, much of the raising of the excavated soil was done by horse whims, an appliance which had been introduced some years previously to replace the old hand-operated Jack Rolls, and which must be familiar to all those who had visited any of the early mining fields in Australia.

He had endeavoured in the preceding notes and diagrams to briefly set forth the early developments of labour-saving appliances in one of the greatest of the British industries—an industry which undoubtedly occupied first place in the adoption of such methods; and, before passing on to the application of modern labour-saving equipments, it may not be out of place to briefly discuss the relation between labour and machinery, since that question is one that has always, in the past, been a prominent factor in any consideration as to the adoption of modern methods and appliances, and even now is in many cases one that cannot be disregarded.

We have seen that immense developments in the direction of replacing manual labour by machinery in the coal-mining industry took place in the early part of the nineteenth (19th) century, the same tendency also showing in many other trades at or about the same time. To the uneducated operative of that period, the machine appeared as a malignant and insatiable monster which had already devoured his brother, and would devour him in turn. He had none of the evidence before him of the benefits which the world has derived as a result of machine processes. The machine was apparently a device of his immemorial enemy—the employer—to starve him and to stay his calling. He acted upon the first impetuous impulse of ignorance and hatred, and took the impotent course of trying to wipe out his foe by violence. In front of the workman of to-day are all the vivid proofs of the uselessness as well as the mischief of resistance to the inevitable. In numberless trades, prejudice against the adoption of any new machine for increasing labour's productivity still exists; and, whatever may have been the outward manifestations of this prejudice, their results have been uniformly mischievous and productive of strife and waste. Yet the growth and development of the machine system is as certain as death. No attempt to resist it has ever been or can be crowned with even a temporary success. The employer, on the other hand, has not been altogether blameless in his attitude towards the matter, and had, he thought, in the past, been forgetful of the fact that the workman's prejudices were more the results of hereditary than deliberate ill-disposition, and he (the employer) had clung to the old-fashioned method until compelled to move, and had regarded the machine less as an agent for increasing labour's value than as a convenient implement for curtailing labour's reward. Machine appliances had revolutionised every industry, but in almost every case the best results have been minimised and their natural development retarded either by the workman's hostility or by the employer's narrow conception of their possibilities. It had been argued that a life of days of unvaried occupation was dementalising; but it was hard to see how the replacement of hand by machine work could in any way lead to worse results in this respect. The production of thousands of articles or details of articles by hand is surely as monotonous as the production of millions by machine. To suggest that machine methods induce mental deterioration was wholly unjustifiable. Repeated operations of any sort were monotonous, but certainly not more so when performed by machine. There could be no doubt that the development of highly organised machine systems had induced a sense of order and of personal self-respect which manual occupation would never bring about; and it certainly was no fable that either the development of these labour-saving devices had brought about an equal elevation of human conditions, or else such better conditions had demanded and hence commanded the device. At all events, the two have practically gone together.

He would now deal with the more practical consideration of modern labour-saving equipments as applied to the handling and transport of materials. The subject, even in this one branch, was so vast that he could but touch generally upon leading features and designs; and, to assist him, he had prepared a number of lantern slides showing typical equipments as installed for various classes of work in different parts of the world.

The appliances for the handling and transport of materials could be generally divided into two classes:—

(1) Those which dealt with the material "continuously"—that was, receive and deliver it in an interrupted stream; and

(2) Those which served to handle it "intermittently" and in general for longer distances.

In this latter case, the material is transported at intervals in a condensed form, such, for example, as is the case with the various forms of cranes and travelling hoists. These two main headings could again be subdivided as follow:—

For continuous handling—

(a) Bucket Elevators or Conveyors.
(b) Spiral or Worm Conveyors.
(c) Trough Cable and "Flight" or "Push Plate" Conveyors.
(d) Reciprocating Conveyors.
(e) Belt or Band Conveyors.
(f) Continuous or Travelling Trough Conveyors.

For intermittent handling—

(a) Cranes of various types.
(b) Aerial Ropeways.
(c) Cable Railways.
(d) Travelling Hoists.
(e) Elevators.
(f) Industrial Railways.

Dealing first with the continuous handling of materials, as carried out by one or other of the many types of "conveyors."

Bucket conveyors consist of two endless bar-link chains, the ends of each link carrying a small flanged roller which runs upon a specially-prepared track. Every link, or sometimes every second link, carries a bucket, each bucket being suspended upon two trunnions—one on each chain of links, each trunnion being fixed to the buckets at a point vertically above the latter's centre of gravity. The chains are evenly and uniformly propelled by special driving gear, the buckets always hanging in an upright position, whether the chain is travelling vertically or horizontally. Each bucket is loaded with the material to be transported as it passes an automatic filling arrangement, which is so designed as to fill each bucket uniformly without spilling. As each bucket passes the point at which the load is to be discharged, it is met by some adjustable device which automatically tips it, and thus empties its contents into special receptacles below.

A typical installation of this type is shown in Plate XX., Fig. 6. In this scheme the conveyor serves three purposes:—

(1) To take coal either from the coal bunker into which the grab bucket discharges the coal direct from the ship's hold, or from the hopper into which railway trucks are discharged, and deliver it either direct into the storage bins above each boiler, or into the main coal storage hoppers.

(2) To take coal from the main storage and deliver it into the boiler coal hoppers.

(3) To remove the ashes from below the boiler furnaces and deliver them into an elevated hopper, from which they can be discharged by gravity either into railway trucks or barges.

This scheme clearly shows the flexibility and simplicity of the bucket conveyor system, which is very extensively used in various parts of the world, and particularly in the handling of fuel and ashes in boiler plants. As a rule, the speed of travel of this type is slow—varying between 40 and 60 feet per minute—the necessary capacity being obtained by installing buckets of considerable size, the largest plants being capable of handling 150 tons of coal per hour. One of the chief advantages of this system is the gentle manner in which it deals with the material to be transported, which in the case of coal is a matter of considerable moment. The power required is generally small, depending chiefly upon the amount of "elevating" to be done; the lubricating of the chains and rollers is automatic in a good installation. Its one chief disadvantage lies in the fact that a break-down of one portion of the chains or gear disorganises the whole system, whereas if separate conveyors and elevators are used, such a result need not necessarily follow.

A somewhat neat and simple application of this type of conveyor is shown in Plate XX., Fig. 7. In this arrangement the conveyor serves only to elevate the coal into a hopper, which hopper, together with the conveyor itself, is power-traversed to a position in front of any boiler, sufficient coal being then discharged by gravity from the hopper into the small bin on top of the mechanical stoker.

Spiral or worm conveyors date back to the time of Archimedes, who, as far as we know, was the first to make use of the principle. In general, this conveyor consists of a spiral plate attached to a central shaft, the whole being supported and revolved in a trough, as shown in Plate XX., Fig. 8, which shows a special water-jacketed screw conveyor for transporting moist sugar. The use of this type is limited to the transport of the finer grades of coal, and to such materials as cement or grain. They have the disadvantage that the dragging action of the material against the face of the spiral and trough results in a considerable wear with some material, and also an increased power consumption. Their special advantage lies in the fact that they occupy a minimum amount of space, require the simplest sort of drive, and are therefore specially adapted to confined spaces. The capacity of a screw conveyor of 12 inches diameter, when handling fine coal, is approximately 1000 cubic feet per hour when running at 90 revolutions per minute, and

1800 cubic feet per hour at 150 revolutions per minute.

Plate XX., Fig. 9, shows a combined installation of bucket and screw conveyor for a coal and ash handling plant. This arrangement is of use when the coal and ash storage bin lies at a point to one side of the vertical plane of the bucket conveyor, the screw conveyors being utilised to transfer the material between the hoppers and the bucket conveyors or elevators.

Push Plate or Trough Cable Conveyors in general consist of a fixed open trough of sheet or cast-iron, as a rule, and the material deposited into this trough is pushed or dragged along by a series of plates attached to a cable or endless chain, which latter, with its attachments, revolves over terminal pulleys so that only half the chain is at work at a time. In well-designed conveyors of this type, the plates are provided with rollers at each end, which run on an angle iron track at either side of the trough or upon the edge of the trough itself, and in this way prevents the plate from scraping along the bottom of the trough, thus ensuring a reduction in wear and tear and in power consumption. Such conveyors are frequently used for coal, coke, ice, ore, or similar materials, and as an example of their capacity the following data may be noted:—

A conveyor with trough 24 inches in width and with plates pitched every 24 inches on the chain, and travel ling at a speed of 100 feet per minute, would convey approximately 30 tons of coal per hour. The pitch of the plates usually ranges between 18 and 36 inches, and the speed between 50 and 180 feet per minute, the lower speed being required for coke and similar friable materials. A simple and cheap modification of this type of conveyor is Plate XXI., Fig. 1, which illustrates three forms of cable trough conveyor, adapted to the handling of timber and logs. This type is also shown in Plate XXI., Figs. 2 and 3, which illustrate the conveyor installed at North Bulli for the handling of slack coal, etc., the capacity of this conveyor being 60 tons per hour through a distance of 650 feet.

A modification of the flight conveyor is the "apron" type, which is frequently installed to handle cases, bales, etc., along warehouse floors, or up inclines of easy grades, and in similar situations. They generally consist of a single or double link chain to which are attached, on the top side, flat boards fairly closely spaced, the whole chain thus providing a continuous surface. The boards are each supported by one or more rollers on each side, which travel upon specially-prepared tracks. When heavy goods are to be handled the conveyor is so installed that the top surface is level with the floor of the building, as shown in Plate XXI., Fig. 4. "A Wool Bale Conveyor," having a capacity of 1000 bales per hour. Where light goods are to be transported, the level of the travelling surface is kept from 2 to 3 feet above floor level, as, for instance, that installed at Messrs. Tooth's Brewery in this city for the handling of cased material.

In certain industries it is frequently desirable to utilise a conveyor for both the transport of the material, and also to thoroughly mix the various ingredients put into it, and for this purpose Reciprocating Conveyors are installed. This appliance is very similar to the "Push Plate" type, with the exception that the plates are traversed backwards and forwards along the top, instead of continually travelling forwards. The plates are usually hinged to a rigid reciprocating bar (in general a "pipe"), the hinges being so arranged as to draw the material forward on the one stroke and to fold up and slide back over the top of the next lot of material on the back stroke, in this way thoroughly mixing the ingredients, and at the same time conveying it forward. This type is frequently used in glassworks and foundries for mixing