MECHANICAL DEVICES FOR LABOUR SAVING.

(Paper by E. CAMDEN SMITH, Sezela.)

It may safely be said that every mechanical device employed in industry has for its object the saving of labour,—the performance of work by mechanical power instead of by muscular effort. Of course there are some mechanical devices which have been designed to utilise muscular energy as their prime mover, as for example in the case of the time-honoured treadmill, and, what may be considered its modern counterpart, the cranking handle of a motor car; but for our present purposes we may class such appliances in the same category as ordinary hand tools, and take into consideration only those which depend upon mechanical power for their operation.

South Africa is supposed to be possessed of a supply of unskilled labour both cheap and plentiful. Unskilled no doubt it is, but its apparent abundance is very greatly discounted by the fact that the native in his present state, with his wants so few and simple, is under very little obligation, and as a matter of fact has no personal inclination, to work a day longer than he can help. Consequently, owing to the difficulty and expense of first obtaining this type of labour, and then retaining it for any useful length of time, I doubt if there are many people present who are ready to admit that our native labour is so cheap as is generally supposed.

The whole history of the manufacturing arts throughout the past hundred and fifty years, considered mainly from an engineering standpoint, has been a continuous record of the gradual displacement of hand-labour in every department of industry by mechanical appliances; and in the manufacture of cane sugar this progress of mechanical science can be traced as clearly as in any other industry. The sugar industry as a whole, however, has been perhaps somewhat slow in taking advantage of mechanical means for facilitating the performance of work; but this may be accounted for by the fact of its being a tropical industry, and as such has been favoured with a good supply of cheap labour—at any rate until recent times. This is an advantage which we all now know to be rapidly disappearing.

It is of course impossible in a short paper to give even a meagre sketch of the mechanical development in the methods of cane sugar manufacture; and it is just as unnecessary for me to attempt it, as a casual reference to any of the standard modern books on sugar will show this development quite clearly. The difficulty is really to know what particular parts of a factory's auxiliary plant to select for discussion. For it must be recognised that many appliances which in the days of their first introduction were hailed merely as welcome and useful adjuncts for the saving of labour have long since become integral and essential parts of the equipment of a factory, the loss or breakdown of which would tend to bring the factory to a temporary standstill. It is merely intended therefore in this paper to describe and discuss some of the minor appliances used in modern sugar factories, as auxiliaries to the main mechanical units with the object of dispensing as far as may be possible with hand labour.

Being one of those industries in which the raw material is as much as ten or twelve times greater in weight than the manufactured product, special consideration has to be given to the problems in connection with the transport and handling of this comparatively large quantity of material throughout the various processes of manufacture. Improvement in machinery and mechanical appliances of every kind has therefore been the first essential to progress. Hand labour can no longer be used indiscriminately, for the simple reason that such hand labour is not available in sufficient quantities. In Natal we have this hard fact driven home to us year by year. Under present economic conditions and the gradual expansion of the country's industries, our available supply of unskilled labour is steadily decreasing, and this deficiency, unless overcome or counteracted, will in a very short time become a serious brake on industrial progress. The only possible immediate way of getting over this difficulty, apart obviously from the improvement in the organisation and application of whatever labour supplies we do possess, is in the intelligent use of mechanical devices designed to assist and expedite the work formerly done by hand.

I say "intelligent use" advisedly, for there are some contrivances which, although of ingenious construction, from a commercial standpoint will not pay their way even in this short-handed country of ours. It may be quite a mistake to assume that every mechanical appliance will do the work it has been designed for as cheaply or as efficiently as can be done by hand labour. Every mechanism has its limits of usefulness, and in some cases these limits are fairly narrow. A labour-saving device may not necessarily be a money-saving device, when compared with the cost of the same work performed by hand; and this

Mechanical Labour Saving Devices.

anomaly exists in Natal to-day, and particularly so on sugar estates, where we are actually obliged to use machinery of a class which is expensive in first cost, running and upkeep, to perform work which really could be done cheaper and more efficiently by hand if only the necessary labour were available.

We meet with an example of this at the very threshold of almost every South African sugar factory. A conspicuous feature of the mill-yard of many modern sugar factories is that of the mechanical apparatus for unloading the cane from the trucks or wagons on to the cane carrier. Such appliances, consisting as they do of mechanical grabs operated either from derrick or overhead travelling gantry cranes electrically or steam driven; cane-rakes; tipping platforms and sloping tables:—such appliances in the present state of things are essential parts of a factory equipment. But with them all, can it be claimed that our carriers are as neatly and as evenly fed as in the days of hand loading? These mechanical unloaders certainly save labour in getting the cane out of the trucks, but I have not heard it seriously contended that they feed the carrier successfully. An amusingly unconscious admission of this shortcoming lies in the re-introduction on many cane-carriers during the last few years of revolving knives for levelling and distributing the feed—a mechanical device which some fifteen years ago was considered to have been rendered more or less unnecessary by improvements in milling plant and the introduction of preparatory splitting rollers or 'Krajewskis,' and has ever since been regarded as obsolete and old fashioned. And moreover, after installing a costly unloading plant which results in a badly fed carrier, to make up for this, apart from the levelling and distributing knives, we are now put to the further expense of what have become known as "double-crushers" armed with all manner of weird and fearsome-looking groovings designed to bite out from a lumpy feed just as much as the mills behind them may be able to chew.

The efficient application of mechanical devices to the work of the mill-yard is a most important but at the same time exceedingly difficult matter. The whole subject is about as tough a problem as the Uba cane itself, and the mechanical devices now in use, although the best we have at present, and as such deserving the consideration of all progressive millers, still fall far short of the ideal. Unfortunately, sugar cane, and particularly our own Uba variety, does not as readily lend itself to mechanical handling as most other agricultural products. No two sticks are alike either in length, diameter or weight; few of them are straight, and having once been loaded into a truck or wagon and shaken down during transit to the factory into a compact mass, to handle this mass efficiently by mechanical means is a problem still awaiting solution.

As regards the work of reaping and loading the cane in the field, very few mechanical appliances are to be found in operation, except possibly for a few hand derrick cranes at field loading stations. The commercially successful cane-cutting machine has yet to make its public appearance. Apart from the ordinary implements of cultivation and tillage common to all forms of agriculture, mechanical science in the cane-field does not appear to have made practical progress beyond the ordinary cane-knife, and up to the present, designers of such appliances can be congratulated only upon their courageous optimism. Still, it must be remembered that without such optimism on the part of pioneers, the history of mechanical progress would not have been what it is.

Within the factory itself, the application of mechanical devices becomes easier inasmuch as the material dealt with—in the liquid form as juice, syrup and molasses, the semi-liquid as massecuite, and finally in the dry state as crystallized sugar—is so much simpler to handle. The mechanical appliances used vary greatly according to the arrangement and layout of each particular factory. In the design of a well-arranged factory the engineer has to aim not only at economy in the hand labour which will be necessary but also to endeavour as far as possible to dispense with a number of mechanical labour-saving devices which may have become necessary in a factory of less efficient design. To first lay out a factory and then proceed to fill it with a multiplicity of minor mechanical devices for saving labour may be engineering of a very questionable character.

However clever and efficient these devices may be in themselves, if by improvement in the design and arrangement of the main plant they may be dispensed with, then they are as much out of place in a modern factory as a small army of hand-labourers. If the hand-labourer is costly, it must be at the same time borne in mind that all mechanical devices are apt to have more or less expensive ways with them, and that the stress of wear and tear on machinery in a sugar factory is by no means light. It is the value of the lighter auxiliary machinery that has to stand the heaviest percentage of depreciation at each annual stock-taking, and in these circumstances the application of minor mechanical devices may become a craze which can be easily overdone.

Having proper regard for these principles therefore, the actual number of minor labour-saving devices in a modern sugar factory should be comparatively few. In the mill-house the chief auxiliary appliances are the mechanical juice strainers and cush-cush elevators and conveyors; these in their present form are the delight of the maintenance mechanic looking for work and the bete noir of the factory chemist out for increased recovery. However, these contrivances have dirty work to perform, and if they succeed only in doing it in a somewhat sloppy manner, their designers may at least claim that the same work cannot be done more cleanly or con-

veniently by hand. Systems of mechanical lubrication of the mill roller bearings are now being fairly widely adopted, and these systems if properly constructed have the decided advantage of being cleaner, more reliable and more economical in oil than any form of hand oiling. Their success however depends more on the proper construction and disposition of the oil channels in the bearing surfaces than in the mere hap-hazard application of oil at a high pressure.

The bagasse, which next to the cane itself is the most bulky material we have to handle in the sugar factory, is very efficiently taken care of and conveyed to the furnaces by simple chain and slat (or paddle) elevators and conveyors, often conveniently driven by chain and sprocket from one of the roller shafts of the last mill. By these conveyors the fuel, amounting in this country to between 30 per cent and 40 per cent of the weight of the cane crushed, is delivered direct into the feed hoppers of the furnaces without any man-handling whatever. In fact the stoking of half a dozen boilers in line should require no more than a couple of men. The removal and stacking of the surplus bagasse—in any factory fortunate enough to have a surplus—can be done by auxiliary conveyors, but in most places the probability of a surplus is so uncertain that most engineers do not consider it worth the trouble to provide special apparatus to deal with it.

The question of the removal and disposal of the ashes from the ashpit, however, is one of considerable importance. The quantity of ash resulting from the combustion of bagasse is much greater than would be supposed by anyone unacquainted with the fact, and the labour generally required for its removal forms a considerable item in the running costs of the factory. Yet I am aware of very few factories in this country where mechanical means are employed for dealing with this waste product, although the use of some suitable conveyor would certainly result in a considerable saving. At present only a few factories that I know of have even a tramline laid into the ashpit to facilitate the removal of ashes by ordinary tip-truck.

In the clarification and boiling departments, apart from the operation of the filter-presses (which by the advent of certain new processes of clarification now appear to be threatened with abolition) the amount of labour employed is not great, and so no very insistent call is made for mechanical labour-saving devices. The installation of a few convenient hoists to assist in the handling of sulphur, lime and other manufacturing requisites is about all that is necessary; yet it is surprising how little these useful and inexpensive appliances are taken advantage of. There is still room—and plenty of it—for some efficient mechanical tools for removing the hard scale which accumulates on the inside surfaces of the evaporator and juice-heater tubes.

At present I know of no really successful mechanical device which has been put into general use to replace hand labour in this very important work, and the necessity for some effective mechanical apparatus is all the more insistent in this country where the amount of scale formed is so great owing to the excessive quantity of lime and sulphur dioxide required for the clarification of the Uba juice. The cleaning of the evaporator tubes at present constitutes a week-end task of no small magnitude, and as this cleaning has generally to be done before the evaporators have had time to cool down to a reasonable temperature, it cannot be wondered at if the work is seldom accomplished thoroughly.

It is not such a long time ago since it was the custom to discharge the massecuite from the vacuum pans into receiving tanks or "coolers" underneath, whence it was removed in due course by pick and shovel into tip-trucks, or in the case of the rather more advanced factories, directly into the mixer of the centrifugal machines. The sight of a half-dozen natives working knee-deep in the sticky mass, used to be one of the vivid impressions that a stranger took away with him after his first visit to a sugar factory. But of course we have changed all that; and have removed both the consumers' objection to the natives standing in the sugar and also the manufacturers' objection to paying the natives for doing so. In the modern factory all this hand labour is replaced by the use of screw conveyors and, where necessary, massecuite pumps and elevators. Crystallizer tanks, fitted with stirring gear, have taken the place of the old coolers, and from the time of its discharge from the pan until it enters the centrifugals the massecuite is kept continually in motion. The entire massecuite-conveying system of a factory producing 120 tons of dry sugar per day should never require more than one attendant for its operation. This compared with the old messy style of handling demonstrates the undoubted advantage of these mechanical devices as applied to this particular class of work.

The removal of the dry sugar as it comes from the centrifugal machines is now usually done by vibratory conveyors, commonly known as "grasshoppers." A grasshopper conveyor, properly designed and applied, is a highly efficient piece of mechanism for this kind of work, being inexpensive in first cost and maintenance, and requiring the minimum of power for its operation. It can be made to convey along the level, and even if necessary up an incline of ten degrees, all qualities of dry crystal sugar. It does not rough-handle the material—a decided advantage in the case of white sugar where it is generally desirable to preserve the gloss and sparkle of the crystals. In this respect the chain and bucket type of elevator almost universally used

is at a disadvantage, and in some places, refineries particularly, this type of elevator is replaced by wire-rope hoists dealing with a few tons of sugar at a time. However, in consideration of the comparative costs of upkeep and operation, the chain-bucket elevators still hold their own.

For drying and sifting the sugar crystals, there are various designs of apparatus, each with its special features. Automatic weighing machines are used to some extent, but as many of these machines depend for their successful operation on the free and uniform flow of the sugar through ports or openings, it is necessary for the sugar to be absolutely dry and free from the slightest tendency towards lumpiness. Special sewing-machines for closing the filled bags have been successfully used for the past few years, and have resulted in the saving of a great amount of labour. The occurrence of an improperly closed bag is now the exception rather than the rule. For the removal of the filled, marked and closed bags, and their stacking into piles or their disposal into railway trucks alongside, light portable elevators, electrically driven, can be installed to save as far as possible the handling and heading of the sacks to the the different parts of the sugar store.

It may be mentioned here that it is in factories of large capacity where the successful application of mechanical devices for labour-saving show up to the greatest advantage. One man can quite as easily look after the operation of a set of conveyors and elevators dealing with ten tons of massecuite per hour as he can a smaller outfit dealing with only one ton per hour. In fact it is only the gradual development and adoption in modern times of mechanical appliances to replace hand labour, coupled of course with the necessary improvements in the methods of cane transport, which has made economically possible the concentration of the manufacturing operations in large central factories. And, provided there are no obstacles in the way of an increased cane supply, the tendency still remains for these large factories to become even larger, without entailing anything like a proportionate increase in the staff and personnel. This tendency, brought about mainly by the improvement in mechanical devices, is not of course peculiar to sugar manufacture, but is common to almost all industries.

Due recognition must also be given to the wide extent to which the modern application of electrical power has made possible the use of so many auxiliary mechanical devices. Every modern sugar factory has its own steam-electric generating plant of a size more or less commensurate with the requirements of the factory, and it is to be noted that the bulk of the electric power generated is absorbed in driving the auxiliary machinery. The majority of the mechanical labour-saving devices mentioned in this paper would indeed cease to be practical were it not for the facilities provided by the electrical distribution of the power necessary for their operation. However, this aspect of the question is one which might well form the subject of a separate paper, and upon which I have no doubt some of our electrical enthusiasts are prepared to write volumes.

In the devising and designing of mechanical aids for labour-saving, there is always, as may be expected, the tendency on the part of inventors to allow their enthusiasm to carry them away. It must always be remembered that under industrial conditions all machinery is called upon to give the maximum of useful work in return for the minimum of care and attention. It is also a generally accepted fact that the less attention called for by any particular piece of machinery the less it is likely to receive. For mechanical apparatus which stands in need of careful nursing there is probably no place more unhealthy than a sugar factory.

The keynote to all successful mechanical design must be that of robust simplicity. The evidence of all engineering history provides ample proof of this. Consider for a moment the internal economy of the early motor cars—those of say twenty-five years ago; some of them can be seen in the museums of Europe and America. These early machines embodied a wealth of mechanical ingenuity and invention compared with which the modern automobile appears almost naked and unadorned. The same kind of development is evident in all progressive engineering. The true mechanical inventor is not merely a maker of monkey's puzzles, but one who finds a means of doing work in a few operations instead of several, and that with as much directness and simplicity as the laws of Nature will permit.

NO DISCUSSION.

The Chairman thanked Mr. Camden Smith for his excellent paper. It was relieved by a vein of humour which he felt sure they all appreciated.