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THE RISE AND PROGRESS OF LIFT CONSTRUCTION IN NEW SOUTH WALES.

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THE following paper, prepared at the request of the Council, has been written with a good deal of diffidence, for two reasons —first, because the author, from the first formation of the Association, has strictly avoided bringing under the notice of the members anything which might savor of an advertisement; and, secondly, because he has been concerned in the introduction of every successful type of lift at present in use in Sydney, and therefore finds it very difficult to do justice to the subject without introducing rather much of the "Ego."

The first machine or power lifts to be used in New South, Wales were probably the "sack tackles" of the early flour mills, of which a few may still be seen in some country places. In their primitive type the winding barrel and its pulley are mounted on a triangular wooden frame, hinged at the base to the timbers of the mill roof, and set horizontally. The apex is supported by a hand line passing over a pulley and down through the different floors of the mill; the hoisting chain being taken off the barrel horizontally, and thence over a sheave, left the frame free to move vertically, and, as the belt pulley on the winding barrel was nearly over the driving pulley on the counter shaft below, the miller, by a skilful

handling of the line, tightened or slackened the belt, and thus the sacks of grain, meal or flour could be raised or lowered as desired.*

In after years, when there was more of the engineer and less of the millwright in evidence, the sack barrel was made of iron to run in fixed bearings above the counter shaft, and the belt was tightened by means of a roller and lever. Since then Robertson's friction gear has been applied to such hoists, as well as plain wheel friction gear, but the highest development of this class of hoisting gear is to be found in the modern lofty roller mills, applied to the man hoist. In these little platform lifts, which often have no enclosures to the front or sides of their platforms, the miller, by means of the hand line, can throw the friction wheel on the hoisting barrel against either the pinion or a brake block, and, standing on the platform, he can pop up and down through the numerous floors of a mill to look after his delicate machinery, at a speed which looks almost as if he was shot out of a gun to a person seeing it for the first time. Suitable as this class of friction lift may be in such special cases, it is manifestly so dependent on the skill of the operator as to be utterly unfit for regular passenger lifts, and although one of these friction lifts was for some time working in a prominent Sydney building, it was generally noticed that experienced persons took to the stairs in preference. That lift is now replaced by hydraulic power.

With the increased size of our modern wool warehouses a demand arose for a speedy system of raising and lowering the bales, and between the years 1878 and 1884 the author designed a great number of friction winches, with Robertson's gear (Plate II. Fig. 1), generally so arranged that a number of them had their pinions all on the one line of shaft, coupled up direct to the crank shaft of a steam engine. In other buildings gas

* The drawing of a flour mill at Tumut, which was exhibited, made by the author for Messrs. P. N. Russell in 1856, was stumbled upon accidentally at Hudson Bros.' works after the above was written. It has several points of interest, but only those connected with the sack tackle are reproduced in Plate I.

engines were used, while in another variety the steam engines had gas-heated boilers. The gas engines, of course, ran continuously, so long as the hoists were required to be used, the governor alone being looked to for economising gas between the different lifts; but in order to work these frictional wool whips by steam, and economising the gas used as fuel, the author introduced a special type of diagonal compound engine, having the two pistons working on to one crank. The starting or stop valve was provided with a loaded lever to keep it shut, from which six or eight lines led away to the several hatches or doorways; this enabled any one of the attendants to the hoisting to start the engine by simply pulling one of the lines, and stop it by letting the line go between every lift. As the engine was on the top floor, or in the roof of the building, it could not be seen by the men working the hoists, and it was therefore necessary to devise a scheme to ensure that it should always start, even if it had stopped on the high pressure centre. The drawing (Plate II. Fig. 2) shows the form of governor, introduced with this object, and patented by the author. It will be noticed that when the governor balls are right down the throttle valve just uncovers a small special opening to admit steam to the low pressure cylinder, but as soon as the engine starts and the governor rises at all, this port is closed, and the passage to the high pressure cylinder is then regulated in the usual way. These plants worked well for years without any trouble, and some are in use still, while others have been swept away to make room for hydraulic machinery as being more progressive; but there are people who still think that for lifting a great number of light loads, such as wool bales, there is nothing to beat the old friction whips. It must be understood that in these machines the friction wheels are much larger than in those used for hoisting coals, the diameter being from 4 ft. to 5 ft.

For lifting goods into warehouses the ordinary crab winch was the only machine in general use in Sydney until about the

year 1855, and these winches were applied to chains or ropes, which ran over a sheave on a projecting derrick above the door, in the upper floor of the store. The use of the warehouse wall cranes, so common in London, never seems to have taken in Sydney; there were two old decayed wooden cranes to be noticed at the upper floors of the Commissariat stores at the Circular Quay until quite recent years, but from 1855 until their removal the author never remembers seeing them worked. Since the advent of hydraulic power such wall cranes have been re-introduced, and examples may now be seen at Garden Island stores, Messrs. Young and Clark's, &c.

As an improvement on the ordinary crab winch for warehouse work, the "American Hoists," as they were called, were introduced into the Sydney warehouses about the year 1855, and had a run for many years, superseding the ordinary cast-iron crab secured to the store floor. The leading feature of the American hoists was the large rope wheel and its endless hauling rope, which passed down through all the warehouse floors and enabled the winch to be worked from the same floor as that on which the goods were being handled, or by men on two or more floors for specially heavy loads. In these machines the pinion on the rope wheel axle was about six or eight inches diameter, and geared into a spur wheel often not more than two feet diameter, set on a long wooden barrel 10 in. or 12 in. diameter, fitted with wrought-iron gudgeons, and although all the workmanship was very rough, yet with a six-foot rope wheel giving a purchase ranging between, say, 18 and 24 to 1, heavy loads could be hoisted by two or three men, while for raising a light load or for overhauling the chain the endless rope and its wheel could be spun round very rapidly. These lifts being erected on the roof timbers, the chain or rope from the hoist barrel led direct to the sheave on the derrick. The friction and noise from the rough cast wheels and bearings, and the wide angle of the lead to the sheave, owing to the small diameter and length of the drum, were great drawbacks, the friction often amounting to

30 or 40 per cent., perhaps. Better work was sometimes put in, and larger barrels used to reduce the angling of chain to sheave, and improvements went on until the other extreme of this class of lift was reached in a few plants which were made from the author's designs, and which were patented. A good example of them was to be seen until lately at Messrs. Virgoe and Chapman's store, George-street North. In these improved hand hoists, instead of the rough wooden barrel of great length and small diameter, with great angular lead of the chain to the sheave, there was a short cast-iron barrel of large diameter, and with right and left-handed spiral grooves cut upon it for two separate wire cables; these cables approached or receded from one another as the drum revolved, and therefore the side anglings, which were very small, balanced or counterbalanced one another. Instead of rough cast-iron bearings, patent anti-friction roller bearings were used, and a cage with safety gear of simple construction was attached to the hoist ropes; the friction was thus, and by good workmanship, brought down to so little, that two men could easily lift what was hard work for three or four men under the old form of machine, and by further overbalancing the cage, by say fifty or sixty pounds, the extra weight would overcome the friction and run the car up by itself when the brake was released. One man in the car would bring the cage down, and raise the balance and overbalance, thus reducing the labour of working materially. Such superior machines will soon pay for their extra cost where hand-power alone is available, but with the every-day use of mechanical power for the increased work of city warehouses, their future use will be limited in Sydney.

Before leaving these little hand lifts, a description of their brake may be interesting, as it has features applicable to many purposes, and the patent has now nearly expired. The drawings (Plate III.) show how, by means of only one line, the attendant can put the brake on and leave it on, and yet, by the same single line, he can take the

brake off and leave it off. Five or six sets of these brakes, with lowering drums, have been fitted in a large wool warehouse to supplement a fine set of hydraulic hoisting machinery, as they answer admirably for lowering.

Screw Hoists.—It is the author's impression that the first screw hoist in the colony was made by the Atlas Company about seventeen years ago. He soon after that designed a number, and they were introduced into many warehouses, notably Messrs. Dalton's, Pitt-street, Robert Gray and Son, York-street, &c., &c., made by well-known firms, and also made by a good many small shops on their own account. There is, however, no doubt that, although one (as per Plate IV.) was designed by the author, an ordinary decent lift of this type, such as would be considered even second rate in the United States, has never yet been made in the colony, and for the following reasons:—In America the making of screw hoists is a special business, and has developed all sorts of refinements under the enormous demand there has been for them.

The ordinary machines made in Sydney had cast-iron worms and cast-iron worm wheels, and they depended generally on emery to make them run smoothly, so as not to shake the building down. Many of them have been removed to make way for hydraulic lifts, but there are enough left to afford a contrast with an American machine by the Whittier Company, of Boston, U.S.A., and similar to that shown on Plate V., only larger, which has recently been re-erected at Messrs. Toohey's Standard Brewery. This hoist was first introduced to Sydney as an exhibit at the Garden Palace in 1879, and is now nearly as good as new, owing to the superior design and workmanship. Its special features are a double grooved right and left-handed barrel, gun metal or phosphor bronze machine-cut worm wheels, two wheels gearing together, two solid steel worms cut on the same shaft right and left and balancing each other without end thrust, the power applied to the main hoisting wheel at two

points instead of one, thus doubling the strength and halving the wear. An easily adjusted automatic stop to top and bottom of lift, and an automatic stop motion to come into play if the cable slacks from obstruction to the descending load, and thus prevent accident should the load slip. Plate V. represents some of the best types of these lifts driven by belts, both from a counter-shaft and directly by steam engines. Of course, these screw machines were never in such demand in Sydney as to justify manufacturers incurring the expense of patterns and plant for making them, but some fine imported examples by the Whittier Company, of Boston, Mass., and Graves, of Rochester, N.Y., are still in use.

The author had the pleasure of going through both these firms' factories during his visit to America, as well as through the great Otis lift factory at Yonkers, N.Y. The Otis Company, however, do not make screw lifts, but apply their special safety patents to spur gear hoists, shown by the drawing (Plate VI.), this Plate has another drawing which represents a screw hoist with an inverted cylinder engine having the worm direct on the crank shaft, as made by Crane, of Philadelphia. Such engines are very wasteful of steam, owing to their special form of valve gear with no lead and lap. One may be seen still at the Norwich Union Office in Hunter-street. Plate VII[B] has special safety brake governor, a model of which was shown at our last exhibition, and is now in the Technical Museum.

The first hydraulic lifts erected in the colony the author believes to be those at the Sugar Works, Pyrmont Bay, from Sir William Armstrong's works. The next erected, and the first made in the colony, were those designed by him for the Works Office and Messrs. Young and Lark's warehouse in Moore-street.

The Works Office lift had an imported steel direct-acting ram, and its speed was hardly one hundred feet per minute it was worked at 44 lb. to the inch from a tank on the roof. This lift is now turned out and is being replaced by one of the

author's patent hydraulic balance lifts, which will work at 700 lbs. pressure from the Hydraulic Company's mains, and travel at from 400 to 500 feet per minute if desired. At Young and Lark's the direct rams were simply made of 4-inch stay tubes, being the strongest then obtainable in the colony; but they lasted all the years until the building was destroyed by the great fire which gave us the continuation of Post Office Place.

The hydraulic jiggers at Messrs. Young and Lark's had chains, not wire cables, and as the author made the sheaves about double the diameter of those on similar machines made in England, he very much reduced the friction, and was led to adopt the system, now common, of angling the sheaves at one end, so that all the turns of the chain were parallel, and wore true on the sheaves whether the ram was in or out. The success of Messrs. Young and Lark's hydraulic lifts led to the system being rapidly extended through the city, and now there are single lifts at work which have cost more than the whole of Messrs. Young and Lark's original plant did, including its four lifts, engine, pumps, and accumulator, complete.

As there was no Hydraulic Power Company in existence at the time just referred to, there was no standard pressure for lift working, and each separate plant was designed to suit the special conditions of the case. When large tanks were required on the roof for fire purposes it was generally the cheapest system to work with low pressure from such a tank. The best of such lifts in Sydney are those of Messrs. Hordern's old buildings, inspected by the members a few weeks ago (Plate VII.), where there are three horizontal hydraulic machines, and two direct lift hydraulic balanced machines to five elevators, working with water from a tank giving an effective pressure of about 32 lb. to the inch. In some cases it was inconvenient to use a tank, and then an accumulator was used for low or medium pressure. Young and Lark's, before referred to, had the accumulator loaded to about 200 lb.

The lifts at Messrs. Farmer and Co.'s were designed for 100 lb., and these lifts were the first ones designed in Sydney on the Otis principle (shown by Plate VIII.). They were designed by the author and supplied by Hudson Bros., and, from results, would appear to have been the most faithfully constructed machines of that type ever fitted in the city. The Otis lift—so called (although its principles were embodied in an English patent 50 years ago), is, to the author's mind, by far the best low pressure suspended lift yet invented, and has a most extended use in America, where it is known as the Baldwin lift, from Cyrus Baldwin, the patentee. The iron work of these lifts is made in the States, something like the razors of the story—to sell—and yields enormous profits. After their use was established in Sydney an enterprising American gentleman came over here and made arrangements to supply the Otis machinery direct, and through the architects, without the intervention of an engineer; the result was that their clients have had, in many cases, to pay again, and have their lifts altered and repaired continually, through inferior work, and these lifts got a bad name. A leading architect in the city who had had some trouble with them told the author he would never have another Otis lift; the fact, however, was his own fault for taking a commission on work he did not understand, and allowing inferior work to be put in, to benefit the contractor at the cost of his principal, who deserved to pay twice over for not employing an engineer for engineer's work. There are no better lifts in the world if they are carried out well. At the present time, however, the advantages of having a connection to the Power Company's mains, and thus dispensing with engine and pumps, is so fully recognised, that these Otis lifts are being continually removed to make way for high pressure lift machines, rather than from any inherent defects.

Before the advent of the Hydraulic Power Company there was, as before stated, no recognised standard pressure for working hydraulic lifts, and some worked satisfactorily with it

as low as 25 lb. from a roof tank. The author had a case where the whole of the machinery had to be on the roof of the building, and therefore a tank was of no use, and of course a loaded accumulator was out of the question, owing to its great weight; this led to the introduction of the compressed air accumulator, on a system patented by the author (Plate IX.). Of this type, four plants, embracing ten lifts, have been for a number of years working in the city, the best known being one at the office of the Mutual Life Office of Victoria, corner of George and Margaret Streets. These plants are regulated in some cases by an internal float, which regulates the quantity of water apart from pressure, while in other examples the regulation is by an increase of pressure shifting the driving belt on to a loose pulley, and *vice versâ*; but in the typical lift just referred to, the water pressure, on reaching 100 lb. to the inch, lifts a loaded ram and opens a jockey valve, which lets the accumulator pressure off by a bye-pass valve on a connection between the suction delivery pipes of the main pumps. This valve, when open, allows the water to circulate, and reduces the consumption of gas in the engine. When the lift is made the pressure falls in the accumulator, the small piston drops; this closes the exhaust jockey valve and then opens a pressure valve, which closes the bye-pass, and the pumps again deliver into the accumulator. You can note on Plate X. (which shows details of pumps and bye-passes) the construction of the covers over the suction valves of the pumps to allow air to be drawn in to supply the accumulator; also note the special construction of the pump, which is such that it does not permit air to lodge in it, and thus no pet cocks are required.

Reference has already been made to the influence which the size of the sheaves has in determining friction in hydraulic jiggers, and it would be thought that the advantages would be obvious to any engineer, but it was most singular the obstinacy with which eminent English firms, such as Armstrong, Waygood, and others, stuck as long as they could to the use of