10TH OCTOBER, 1889.

THE EPICYCLIC GRAB DREDGER.

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THE mere novelty of a design, the author is aware, is not sufficient ground for pressing it upon public notice; but he hopes to satisfy the gentlemen he has the pleasure of addressing this evening, that the subject matter of this paper is not only a new contrivance, but that it possesses features which render it distinctly superior to any other machine for effecting similar operations.

Our modern grab dredges are descendants from an exceedingly ancient family; but, unlike some scions of old stock, instead of falling into a state of uselessness and decay, they have, in recent times, adapted themselves to the new sources of power, and have proved themselves to possess under their alliance with steam, unexpected usefulness, and they are continually improving and increasing in effectiveness.

In New South Wales alone, the author believes more than a dozen patents in connection with grab-dredging have been granted within the last two years, and in Victoria considerably more than that number of rights have been acquired in the same period; while Queensland and the other Australian colonies have all been active in this branch of mechanical engineering. The economy, efficiency, and convenience attained by using these machines has been so marked that their numbers are increasing daily; and he believes that the near future will witness a still greater perception of the capacity of the grab-dredger for dealing with certain classes of work.

He will now direct your attention to these working models and drawings, by means of which he wishes to illustrate some of

the most modern of our grab-dredgers; and particularly to this model of the excellent machine made by Messrs. Priestman Brothers, and to this miniature Epicyclic Dredger, which he will presently put into actual operation, so that you may witness their respective methods of working, and judge of their relative values.

Grabs have been designed to work by means of one, two and three chains. He will not attempt to occupy your time by describing all these machines, but as there may be some members here whose practice has not brought them into contact with these instruments, he will briefly point out the peculiar construction of a good sample of each kind.

The flat model exhibited is not meant to be a scale representation of any particular grab, but it is a fair sample of the system of pawls, triggers and catches requisite to the whole system of single-chain grabs. Mr. Stothert, in speaking of the single-chain grab, during a discussion at a meeting of the Institute of Civil Engineers, London, gave an account of an excellent performance by grabs of this description.

Two ten-ton cranes, each working a single chain grab of 40 cubic feet capacity, were placed on a hopper barge having a capacity of 500 tons. These grabs brought up 50 per cent. more than their supposed load or 3 tons per cut. Each crane made as many as 60 lifts in one hour, or 180 tons per crane, the two machines thus placing 360 tons in the hopper every hour—filling it, and the barge being ready for moving out to sea in less than two hours. It must be allowed that such a performance is very good work. But Mr. Stothert, who is a manufacturer of these machines, while maintaining that they have good qualities of their own not to be overlooked, and particularly that this form can be hooked on to any ordinary jib crane, and immediately put to work, admitted that the double-chain system of Messrs. Priestman Brothers was superior.

The objections to the single chain system are as follows:—

1. The catches and triggers which complicate the grab are subject to rough usage, and are submerged and brought into contact with the rough and foul stuff being dredged, and they are

as a consequence very liable to wear, damage and fouling, thereby causing loss of time.

2. If a snag or other immovable object be seized under water, great trouble is involved in releasing this form of grab, and divers may be required to set it free, or at times the grab may even be lost.

3. If the chain breaks, much expense is caused in recovering the grab, whereas those having more than one chain will always have one connection left.

4. They will only discharge at the particular height for which the gear has been adjusted.

The next model is a perfect reduction of the best type of double-chain close-tine grab. Its action and structure are so simple as to require little description, and its performance is excellent.

The treble-chain system requires a special grab, and also a special crane, both parts being the subject of a patent granted to Mr. C. W. Maclean, of Melbourne. You see by the drawing exhibited that this is a ponderous and somewhat complicated machine. The author has not seen these dredges, but he believes there are several at work on the Yarra, and they are reported to be exceedingly powerful and effective contrivances. The complication of its parts, its weight, and the fact that its action is entirely dependent on chains working in cupped or pitch wheels, will be found objectionable features, he thinks, in this dredger, and sufficient, notwithstanding its effectiveness, to prevent its becoming a powerful rival to the double-chain machines.

The double-chain system is at the present time best known by the examples manufactured by Messrs. Rose, Downs, and Thompson, Mr. J. B. Wilson, and by Messrs. Priestman Brothers. Messrs. Rose, Downs and Thompson's gear is somewhat complicated. It consists, as you may observe, practically of two winches, one to each chain, and one winch driven off the other by a pitched-chain messenger. Mr. Wilson's gear also, is in fact a two-winch system, one winch being driven by a messenger-chain connecting it with the other winch.

The author will now call your attention to the dredger of the Messrs. Priestman. The grab dredging-gear patented by this firm is very generally considered the best contrivance of its sort now known, and he trusts that nothing he may say in this Paper will be construed as indicating that he has a poor opinion of that firm's excellent mechanism; on the contrary, looking upon the Priestman crane as the best, he has attempted to study out an improvement upon it, and unless he has succeeded in designing a gear which distinctly overcomes some acknowledged difficulty and effects a superior result, then the Epicyclic Dredger has no excuse for remaining upon the scene. In the Priestman crane the closing and hoisting chain is wound on to a winch barrel, and the opening chain is taken in by means of a heavy weight suspended from a number of pulleys over which the chain is rove. The opening chain is passed under a cupped pulley controlled by a brake, and it is by this brake holding the chain that the grab is made to release its spoil. This weight may vary from 43 cwt. with a four-sheave purchase, to 90 cwt. with ten sheaves, according to the depth at which the dredging is being done; and supposing that the vertical range of the weight is 8ft. in each case, the former arrangement would suit for a range of about 11 fathoms for the grab, and the latter for nearly 27 fathoms range, the strain on the fall of the chain being in the former case $5\frac{1}{2}$cwt. and in the latter $4\frac{1}{2}$cwt. It is this tension on the opening chain which tends to lift the grab off the ground precisely when it is desirable that every ounce of its weight should assist in forcing its cutting edges into the spoil, that strikes an observer as the most obvious defect in this system. Cupped wheels and pitch chains, such as are used for the break-gear, are also things to be got rid of, if possible. The author is aware that Mr. Priestman contends that his dredgers may be worked without strain on the opening chain during the time in which the cut is being made. His argument is this: That for any given depth of dredging the weight on the opening gear should be reduced until the pendant chain will so nearly balance it that the momentum, acquired during the fall of the grab, will cause the chain to run

out and the weight to rise some little time after the ground has been struck. The driver should then catch this slack chain smartly with his brake, and hold it while the cut is made. This feat may be accomplished by accident, but in ordinary practice it is not. In the event of the Priestman dredger seizing a snag or other thing which cannot be lifted, it is a tedious and difficult operation to release it. The attendants must in such a case lash the two chains together, some slack being passed out on the closing chain. Now, on heaving with the crane, the grab will open and come up. These grabs weigh as much as two tons, and require very careful handling; it will be evident that this manœuvering is troublesome. Shingle, mud and broken rock can be raised in first-rate style by these machines, and so can free sand and some clays, but hard clays and some impacted and cemented sands almost defy the attacks of these tools. The machine the author will now describe has been designed with an eye to removing some of the difficulties he has mentioned as peculiar to the working of the best form of grab dredges hitherto known, and also with the hope that the attacking power of the grab might be made more suitable for operating on ground which is now considered too obstinate for it to deal with. It will be seen, on inspection of plates VI and VII, Figs. 1, 2 and 3, illustrating his invention, that it consists of a very simple arrangement of two loose barrels (E and F) placed on the main shaft (D) of a crane or winch, one barrel (F) for the opening chain and one (E) for the closing chain. Each barrel has an independent brake (G′ and G″), and the pair of barrels are driven off the main shaft by a nest of epicyclic wheels (O,O) and (P,P). It will be noticed that the two barrels, as shown, are of different diameters, but he claims to make them either according to the illustration, or to make them of similar diameters. The two barrels of the model before you, for instance, are of the same size. The method of giving motion to the shaft (D) may also be varied. In Figs. 1, 2 and 3, Plate VI, this shaft is shown as being driven by a crank-arm (L), fixed in a disc (K), keyed on the shaft, The exposed end of the crank-arm engages in a radial slot (M), wrought in the friction-wheel (I). This friction-wheel is driven

by being brought into contact with the friction-pulley (H), which is fixed on the engine shaft. The wheel (I) is caused to advance for making contact or to recede by turning the eccentric (J), which is shipped loosely on the shaft (D), by means of the lever (J′), and the wheel, which runs freely on this eccentric, is thus moved through the very small arc required to place it in contact either with the driving pulley (H), or the retarding brake (J″).

The Epicyclic machine will make its cut with an absolutely slack opening chain; it has no pitch-chains or cupped wheels; it will release a snag or other immovable object in an instant, and take a fresh bite without being even raised out of the water; it uses two small chains, or ropes if desired, instead of a large chain and a small one, and each of its chains or ropes must do exactly half the work. If the ground is of a hard nature this machine can be caused to repeatedly bite or gnaw the surface, scarifying and breaking up the ground before making the final cut. He hopes directly to be able to show by experiment that on easily-penetrated ground his gear will do 20 per cent. more work than the Priestman gear can, and on hard ground 100 per cent. more. The crane as made on his method is also a remarkably useful machine for general lifting purposes. Hook on one chain only and we have a a quick purchase for light loads, and when both are used a slow motion for heavy lifts. By hooking both chains on at different parts of the log or pile, it may be handled very conveniently, since we may bring it vertically or end on through a hatch, then incline it or bring it horizontal, just as required. This crane will also work a bailer, which may hold 600 or 800 gallons, and discharge that quantity each minute, or say, 40,000 gallons in each hour—a useful quality in a machine intended to clear flooded works, &c.

Before making experiments the author may say that he has proportioned the model of the Priestman gear faithfully after a good example of one of that firm's dredgers, but that he has adjusted the strain on the opening chain to give more favourable conditions in the model than exist in the actual dredger, the strain on the chain being in the model ·14 of the grab's weight, and in the actual dredger ·16 of the grab's weight.

He will first operate the Priestman model on unpacked sand, making four cuts and weighing the total spoil raised, and after that he will make the same number of cuts with the Epicyclic gear and note the difference of weight in spoil raised. It will be observed that he has not reproduced the cupped wheel and brake-band, as applied by Priestman to the opening chain, simply because it saved complication to omit it, and the same effect is obtained by seizing the opening chain with the hand.

In working grab dredgers the bucket is usually allowed to fall upon the ground with momentum, but for these experimental trials he proposes to lower the grab gently, so that there may be no question as to variations of height of fall and velocity. Both these conditions are favourable to the Priestman model, because the brake causes additional frictional resistance, and because the Epicyclic dredger allows the grab to fall more freely than can any machine in which the grab has to heave up a ponderous weight as it falls, and therefore dropping the grab with added momentum must be favourable to the latter.

In each case he will also show the method of releasing the grab when it has become fast to a snag. Then he will operate each model on hard packed sand, and show how much more effective the new gear is on this resisting material. After that he will show how the crane built on his method works for ordinary lifting purposes, and you will see that with a light load on one chain only, the engine will make for any given lift but half the number of turns that would be made with a heavy load or two chains; and finally he will show the crane working as a bailer.

Having now attached the model of the close-tined grab (before exhibited to you as the most approved form of such apparatus to the Priestman gearing) he will proceed to make four cuts on this box of loose but damp sea-sand. Seizing the opening chain he allows the expanded grab gently to descend and rest upon the spoil which is to be raised; then releases the opening chain, and heaves on the closing and lifting chain. You will perceive that as the cutting edges approach each other the grab descends somewhat, and, as a consequence, hauls on the opening chain, thus lifting the

counterweight, and depriving the grab not only of the proportion of the counterpoise weight due to the block and chain gearing, but also of the increase of that strain due to frictional resistance, the sum of these undesirable forces amounting to probably one-fifth of the grab's weight. The grab being closed, we continue winding the closing chain upon the winch-barrel, thus raising the machine and the contained sand. Again seizing the opening chain and lowering away with the winch and thus discharge the spoil. The four cuts of sand now secured have a gross weight of 13·5 pounds, the time occupied by the work being four minutes. We will now connect the Epicyclic gearing to the same grab, and, applying the brake of the spinning barrel of the winch, lower the opened grab on to the loose and damp sand as before. After the grab has gently come to rest on the sand, release all brakes, and continue to lower away for a little time on the winch, so as to make the opening chain quite slack, and a couple of feet, as per scale, to spare. Now apply the break of the opening barrel once more and wind away with the winch, thus hauling on the closing chain. Observe the opening chain, and you will see that it remains perfectly free, although the excavator penetrates more deeply than it did in the former experiment. As soon as the grab is closed, release the brake and continue winding with the winch. You will note that the two chains adjust themselves, each accepting half the load, and the grab and spoil are raised. Again apply the opening brake and lower away with the winch, releasing the sand from the opened excavator. As before, we will make four such cuts. The gross weight amounts to seventeen pounds, and the time required was four minutes. By comparing these figures, it will be seen that the Epicyclic has lifted 3·5 pounds more than the Priestman in the same time, or 25·9 per cent. more.

We will now make some comparative trials of the same mechanisms on the damp sand rammed into a consolidated mass, so as to represent some of the more refractory materials which grabs find it so difficult to operate upon. As the Epicyclic is connected we will take it first this time. The opening brake being applied, we lower away with the winch and deposit the open grab

gently upon the now hardened mass of sand. To make any serious impression on this surface, the author must bring the scarifying or breaking-up action of his machine into force. To effect this, he releases the opening break and pays out both chains quite slack; then applies the opening brake and heaves on the closing chains, partly closing the grab; then again releasing the opening brake, he again pays out slack chain, and this time applies the closing brake and heaves on the opening chain, thus re-opening the grab; and so on, opening and partly closing the grab three times before entirely closing and lifting it and the contained sand. This entire series of motions he repeats four times (four charges total up to 12·5lb.), the time required being 6 minutes. Now to attach the excavator to the Priestman gear for trial on hard ground. You will here observe that this method allows of but one action, and therefore the grab is handled just as it was in the first trial on soft sand. Having made the four cuts and weighed the four charges, we find that four pounds of sand have been secured in 4 minutes, the Epicyclic thus raising 8·5 pounds, or 212·5 per cent. more than the Priestman, but requiring 6 minutes or 50 per cent. more time. Allowing for time, the absolute increase of effect due to his patent gear is 108·3 per cent. when working on hard sand.

Having now terminated his dredging experiments, he will illustrate the recovery of a fouled grab by both methods, the Priestman first. Placing this cloth on the sand, he lowers the extended grab on to it, and causes it to close on the fabric, which, you will please assume, to be something that cannot be moved. The difficulty now is to disgorge this object and recover the excavator. To effect this, we must lower away with the winch, paying out, say, four feet of the slack upon the closing and hoisting chain. Now put a secure lashing round both the hoisting and the opening chain just above the water line, on heaving on the winch the excavator opens and releases the immovable object, and is brought up abnormally suspended by the opening chain. If the water be of considerable depth the lashings must be removed and replaced several times before the grab can be placed on the barge and re-started.

We will now connect the Epicyclic gear and foul the grab as before, by simply applying the brake of the closing barrel, first paying out slack chain, and then heaving on the opening chain the grab is at once set free, and can be moved from the neighbourhood of the snag, and dredging resumed without hoisting the excavator.

The author will now show you that the crane, which is fitted with his patent gear, with the object of making it capable of working a grab for dredging, loses none of its usefulness as an ordinary crane, but on the contrary is a far more effective lifting machine than any of those in general use. Hanging this light case from one of the chains from which the grab has been detached, and applying the brake to the barrel of the other chain, it can be hoisted to the jib-head in six turns of the main shaft. Now let us suppose that this case is a heavy package of machinery, not to be whipped up in that speedy manner. Simply hook both chains on to it and hoist, and the case is now lifted to the jib head with twelve turns of the main shaft. This small log may be considered a pile or part of a cargo of timber; we will attach both chains, each one at a point about equi-distant from the centre of the log. Now while lifting with the winch, we can, by adjusting the brakes, place the log either horizontally, vertically, or at any angle of inclination; or we turn it end for end while either lifting or lowering.

This model of a bailing tank may be supposed to have a capacity of 800 gallons; it is rectangular and open-topped. It has a chain-bridle attached about half-way down one side for connecting opening chain, and another bridle near the lip of the other side for attaching the closing chain. Connect the chains, and, placing the machine over this tank of water, you can see it is possible by manipulating the winch, much the same as for dredging, to lower the bailer with the mouth turned vertically into the water, fill it, turn the mouth horizontally, lift it in that position, and then again capsize and discharge it, ready again to descend and re-charge.

[No discussion took place on this paper, as Mr. Davies stated that members would be afforded an opportunity of witnessing a full-sized machine, now in course of construction, in operation at an early date.—Ed.]