ON THE IMPROVED TRAVERSING CRANES AT CREWE LOCOMOTIVE WORKS.

By Mr. JOHN RAMSBOTTOM, of Crewe.

The Traversing Cranes described in the present paper are employed in the locomotive shops of the London and North Western Railway at Crewe, where they were designed and erected by the writer. They were seen in action by the members on the occasion of their visit to the Crewe works in the excursion at the Liverpool meeting of the Institution last summer. From the interest manifested in them on that occasion and the numerous enquiries that have since been made respecting them, the writer has thought that a description of the principle and construction of these cranes may be acceptable to the members.

There are seven of these cranes in use at the Crewe works, which have been working successfully for some time, the first having now been three years in constant work. They are driven by power and are so constructed as to be driven by a light endless cord of small diameter, extending throughout the entire length of the shop traversed by the crane. This cord is driven at a very high speed, nearly 60 miles an hour; in consequence of which only a very light driving pressure is required on the shifting gear of the crane. The driving cord is kept in uniform tension by the action of a constant weight; and is arranged so as to allow of the cranes working and traversing in every direction without sensibly affecting the length of the cord.

The cranes are of two classes: Longitudinal Overhead Traversers, of which there are two pairs in the engine repairing shop, lifting loads up to 25 tons; and Traversing Jib Cranes, of which there is one pair in the wheel shop, lifting 4 tons. The cranes are all driven by endless cords running along the top of the shops close to the roof tie-beams. The overhead traversers are worked in each case by a man seated on a platform attached to the crab and moving with it; and the jib cranes by a man standing below at the foot of the crane and walking along with it when traversing: each man having control over all the lifting, lowering, and traversing movements, by a set of handles.

The construction of the cranes is shown in Plates 9 to 18. Figs. 1 to 17, Plates 9 to 15, show the overhead traverser; and Figs. 24 to 32, Plates 16 to 18, the jib crane.

Fig. 1, Plate 9, is a transverse section of the engine repairing shop; and Fig. 2 is a plan, shortened in the direction of the length of the shop. The two pairs of Overhead Traversers A A and B B work on two parallel sets of rails, each having a span of 40 feet 7 inches and a longitudinal traverse of 270 feet. The girders forming the longitudinal rails are carried by the side walls and by columns at a height of 16 feet above the floor. The two pairs of traversers are separately worked by the endless cords C C and D D, each cord being carried down the side of the shop, and returning along the same side but at 4 feet lower level. The course of the cords is indicated by the arrows. In order to communicate motion to the traverser and crab, the driving portion of the cord is carried across each traverser to the further end and back again before passing on to the main driving pulley.

The cord is returned round a tightening pulley E, 4 feet diameter, at the end of the shop, Fig. 1, Plate 9, carried in a horizontal sliding frame F, as shown to a larger scale in Figs. 3 and 4, Plate 10. To this frame is connected a weight G, Fig. 1, for the purpose of giving the requisite tension to the driving cord, and taking up any stretching or temporary variation of length due to change of load or weather. The tightening frame F has a traverse across the end wall of the shop giving a range of 34 feet, which takes up a variation in the length of the cord equal to twice that amount.

The Traverser is shown in the side elevation and plan, Figs. 5 and 6, Plate 11; and Figs. 7 and 8, Plate 12, are transverse sections at the end and at the centre. It is constructed of two timber beams H H, trussed with wrought iron bars; and the whole is carried by four flanged wheels mounted in the cast iron carriages into which the ends of the beams H are fixed.

The Longitudinal Driving Gear is placed at J, Figs. 5 and 6, Plate 11, at the end of the traverser, and is shown to a larger scale in Fig. 13, Plate 14. It consists of a double friction-disc K, keyed on the vertical spindle of the driving pulley L in which the driving cord runs. The spindle footstep and guide M are carried by the double lever N, which is connected to the short lever on the horizontal shaft O. This shaft extends across the whole length of the traverser, as shown at O O in Figs. 10 and 12, Plate 13, and is under the control of the attendant by means of the lever I sliding on the shaft along with the crab, whereby the friction disc K, Fig. 13, is raised or lowered so as to be brought in contact with the friction pulley P either at bottom or at top, according to the direction in which the traverser is required to move. The motion of the friction pulley P is reduced by the worm and worm wheel and spur gear to the pinion shaft Q, which is carried across the traverser from end to end and by means of pinions drives the carrying wheels at each end of the traverser, Fig. 6. The frictional surfaces of the driving disc K are composed of rings of alder wood cut with the fibre on end; the edges of the wood rings are bevilled, and they are secured in their places by an inner iron ring, as shown black in Fig. 13.

The pulleys for returning the driving cord from the further end of the traverser are shown separately in Fig. 17, Plate 15. They work in the inclined positions shown, in order that the cord which has passed across the traverser may be returned at 1½ inch lower level, and at the same time in a different vertical plane, as shown at A. This is done in order to facilitate the lowering and lifting movements, as afterwards described, and further in order that the two cords which are travelling in opposite directions may not rub against each other by the swagging of either of them. These pulleys are keyed upon wrought iron spindles running in long bearings, which are placed wholly below the pulleys, on account of the small amount of clearance between the roof principals and the pulleys, only $2\frac{1}{2}$ inches. The weight of the pulley and spindle is taken by a brass footstep. The bearings are of cast iron, and are chambered at the top for the convenience of oiling, which is done by raising the pulley by hand until the spout of an ordinary oil can will reach the chamber. In the event of the cord leaving the pulleys from any cause, guards are provided, as shown at A, in order to prevent accident.

The Crab of the traverser is shown in Figs. 9 to 12, Plates 12 and 13, which give a transverse section, a longitudinal section, and a plan. It consists of a pair of cast iron frames, carrying the chain barrel, lifting and lowering, and traversing gear; the whole being carried upon four flanged wheels running on rails bolted upon the traverser beams H H.

The Lifting and Lowering Gear is partly shown in detail to a larger scale in Fig. 14, Plate 14. The double grooved pulley R is keyed to the vertical spindle, and is put in motion when the cord is pressed into either of its grooves by the presser pulleys S and T. These pulleys are of cast iron, 8 inches working diameter, and are mounted on short wrought iron studs tapped into the radial arm Z on which they are carried, as shown in Figs. 15 and 16, Plate 14, and in the plans, Figs. 11 and 12, Plate 13. The heads of the studs are recessed to form a receptacle for oil, Figs. 15 and 16, the oiling being done from the top, through a hole drilled in the stud for that purpose. When at rest the pulleys are clear of the cord, and are therefore only running when work is being done. The stud bearings are necessarily short, in consequence of the small amount of clearance between the pulleys and the roof tie-beams, which at this point does not exceed $1\frac{1}{2}$ inches, as seen in Figs. 9 and 10. The grooves in the driving pulley R, Fig. 14, are of different diameters, whereby different velocities are obtained, the smaller being used for lowering and the larger for lifting; and as the two portions of the driving cord are running constantly in opposite directions, the reversing is obtained by simply pressing one or other of the cords into contact with the driving pulley, by the presser pulley S or T, on the same side of the driving pulley in both cases, with a pressure proportionate to the work to be done. The radial arm Z carrying the presser pulleys S and T turns upon the spindle A, Fig. 14; and the toothed segment B, which is part of the same casting as the arm Z, gears into a rack at the end of the rod C, Fig. 11, attached to the hand lever D. The lever D is under the control of the attendant, and is held in its place by a spring catch in a notched sector.

From the driving pulley R, Figs. 9 and 12, Plates 12 and 13, the velocity of the driving cord is transmitted and reduced through the worm and worm wheel U, Fig. 12. In order to economise space the shaft of the worm wheel U is carried through the hollow shaft on which the chain barrel V and its spur wheels are mounted. The number of revolutions is further reduced by a spur pinion and wheel to the shaft W, on which slide the two pinions X X of different diameters, gearing alternately into the spur wheels Y Y also of different diameters, which are keyed to the chain barrel V, so as to give a greater or less purchase as required for heavy or light loads, the ratio of difference being about 4 to 1.

The Cross Traversing Gear E, Fig. 12, Plate 13, is similar in principle to the lifting gear. The two grooves of the driving pulley F are however of the same diameter in this case, the velocity of traverse being the same in both directions. The pulley F is placed on the opposite side of the driving cord to the pulley R of the lifting gear, so that the cord when used for traversing may not foul the lifting pulley. The radial arm G carrying the presser pulleys belonging to the driving pulley F is worked by a rack and segment from the hand lever J, Fig. 11, which is adjacent to the hand lever D of the lifting and lowering motion.

The cross and longitudinal traversing movements are made at the rate of 30 feet per minute. The heavy loads are lifted at the rate of 1 foot 7½ inches per minute, and the light loads at the rate of 6 feet 5 inches per minute.

Fig. 24, Plate 16, is a transverse section of the wheel shop containing the pair of Traversing Jib Cranes; and Fig. 25 is a plan, shortened in the direction of the length of the shop. Figs. 26 and 27, Plate 17, are a vertical section and front elevation of one of the cranes. Each of the two jib cranes A A has a radius of $8\frac{1}{2}$ feet, and a traverse of 120 feet along a single rail bolted to the floor; and is guided at the top by a pair of rolled girders B B, Fig. 27, of an $\vdash\!\dashv$ section. The top of the crane carries the guide roller C, which just fits in between the two girders B and serves to support the crane laterally when lifting on either side of the rail. The driving cord is carried down the shop and back again, as indicated by the arrows in the plan, Fig. 25, just below the roof tie-beams. In its course it is passed round nearly half the circumference of the driving pulley D of each crane, by means of the two guide pulleys E E, the one crane being driven by the outgoing cord and the other by the return cord. The guide pulleys E are carried by a guide bracket upon the top of the crane post, Fig. 26, and traverse with the crane. The tightening gear F, Fig. 25, is similar in its action to that already described for the overhead traverser.

The crane is constructed of the plate box-frame G, Figs. 26 and 27, Plate 17, forming the base, and carrying the vertical cast iron pillar H, round which the outer casing and its attached jib K revolve. The driving pulley D is keyed to the vertical shaft I passing down the centre of the crane post, and from this shaft all the motions are taken by means of frictional gear. The lifting and lowering gear J, shown to a larger scale in Figs. 29 and 30, Plate 18, consists of the double friction-cone of cast iron L L, sliding on a fast key on the vertical shaft I, and moved up or down as required to bring the lower or upper frictional surfaces into contact with the single friction-cone M, from which the motion is transmitted and reduced through the worm wheel and train of spur gear to the chain barrel, as shown at J in Fig. 26. The whole is carried by the cast iron bracket N, which is bolted to the outer casing of the crane pillar and revolves with it. The bearings for the driving shaft I above and below the double friction-cone L are of cast iron; but the horizontal worm-spindle runs in a brass bush, Fig. 29, the end

K

pressure when lifting being taken by the collar of the bush and the end step. The driving cones are raised or lowered by means of the double lever O O and brass clutches, as shown in the plan, Fig. 30, on each side of the boss of the lower cone L. These levers are placed under the cones instead of between them, in order that any oil thrown off the collars may not affect the frictional surface. The clutch levers are connected by an external rod to the hand lever P, Fig. 26, at a convenient height for the man working the crane.

The traversing motion shown at Q in Fig. 26, Plate 17, is shown to a larger scale in Fig. 31, Plate 18. It is similar in principle to the lifting gear, consisting of the single friction-cone R keyed on the bottom of the vertical driving shaft I, which communicates a backward or forward traverse when either face of the double cone S is brought into driving contact as required; the motion being transmitted to the carrying wheels by the horizontal shaft T through the trains of worm and spur gear indicated in Fig. 26. The traversing gear is applied to both the carrying wheels in order that there may be sufficient adhesion when the load overhangs either end of the crane, which would not be the case if only one wheel were driven and the load overhung the opposite end of the crane. The double cone S is moved along the horizontal shaft T by clutch levers U, Fig. 31, in a similar manner to the lifting and lowering gear, the clutch being worked by the hand lever V, Fig. 26. The double cones S, Fig. 31, are of cast iron: but the driving cone R is composed of a cone of alder wood, which is fastened by lock nuts and studs to a wrought iron disc screwed on the coned end of the vertical shaft I, as shown in the section, Fig. 32. The traversing gear is carried by the bracket W, Fig. 31, which is bolted to the foot of the centre pillar H, Fig. 26. The bearings of the horizontal shaft T are of cast iron; and the bearing of the foot of the driving shaft I is of brass, the weight of the shaft being taken by the collar of the bush, on which rest the lock nuts screwed on the shaft at that point, as shown in Fig. 31, forming an adjustable collar for taking up the wear and keeping the driving pulley D, Fig. 26, at the right level for the driving cord. The horizontal shaft T is carried at the ends by cast iron brackets, with brass bushes to take the end thrust in traversing: the worms are pinned on the shaft.

The jib K of the crane, Figs. 26 and 27, Plate 17, is formed of two wrought iron bars, stiffened laterally by diagonal trussing, and tied at the projecting end to the outer pillar of the crane by two tie rods. The bottom pressure of the jib is taken by the roller X, which is carried in a cast iron box bolted between the projecting sides of the outer casing of the crane, and runs on the bevilled base of the cast iron crane pillar H. The base G of the crane is sufficiently long to secure its stability when the maximum load is lifted over the rail, or lengthways of the crane base.

In these cranes, owing to the high speed at which the driving cord runs, the power is applied at a very long leverage over the load to be lifted. The velocity of the cord is in all cases 5000 feet per minute; and in the overhead traversers the heavy loads are lifted at the rate of 1 foot $7\frac{1}{2}$ inches per minute, the total leverage being slightly over 3000 to 1; so that in this case the driving power required to lift the maximum load of 25 tons is only 18 lbs. irrespective of friction. When lifting light loads with the traversers the speed of lifting is increased to 6 feet 5 inches per minute, being a leverage of nearly 800 to 1; and in the jib cranes of the wheel shop, which lift up to 4 tons, the speed of lifting is 5 feet $1\frac{1}{2}$ inches per minute, giving a leverage of nearly 1000 to 1. The actual power required in the traversers for lifting a load of 9 tons, besides the snatch block and chain, has been found to be 17 lbs. acting at the circumference of the driving pulley at the point where the driving cord acts upon it; and the total leverage over the load being 3000 to 1, the portion required to sustain the load is 6 lbs., leaving 11 lbs. as the working power required to overcome the friction of the crab gear under that load. The crab when unloaded is found to require a driving power of $1\frac{1}{3}$ lbs. to overcome its friction.

The tightening weight G, Figs. 1 and 2, Plate 9, for the repairing shop traverser, is 218 lbs., or 109 lbs. on each half of the driving cord; and this is found to be about the best working strain, for keeping the rope steady and giving the required hold on the main driving pulley and the horizontal pulleys of the crab. The limit of the weight G is that required to give steadiness to the transverse portion of the cord situated between the crab pulleys and the end of the traverser, which is unsupported for a length of about 30 feet when the crab is close to one end of the traverser.

The driving cords employed are soft white cotton cords, $\frac{5}{8}$ inch diameter when new, and weighing about $1\frac{1}{2}$ ounce per foot: they soon become reduced to 9-16ths inch by stretching, and are found to last about eight months in constant work. In the overhead traverser which has been in constant work in the boiler shop for about three years with a single crab arranged to lift 6 tons, a smaller cord of about $\frac{3}{8}$ inch diameter was originally used; it was however found desirable to adopt a cord of $\frac{1}{2}$ inch diameter afterwards. The total length of each of the two driving cords in the repairing shop is 800 feet, in the wheel shop 320 feet, and in the boiler shop 560 feet. The wear and tear of the cord is considered to be mainly influenced by the bends to which it is subjected in its course; and the pulleys over which it is bent are therefore made none of them less than 18 inches diameter or about 30 times the diameter of the cord, excepting only the presser pulleys of 8 inches diameter for pressing the cord into the grooves of the driving pulleys in the overhead traversers. In the jib cranes the cord has eleven bends at all times, whether the two cranes are working or not; and in the repairing shop traversers the cord has twelve bends when both cranes are not working, sixteen when both are lifting or cross traversing alone, and twenty when both cranes are cross traversing and also lifting.

The groove of the driving pulleys is made **V** shaped at an angle of 30 degrees, and smaller at the bottom than the cord, as shown in the full size section, Fig. 21, Plate 15, so that the cord is gripped between the inclined sides and does not reach the bottom of the groove. In the guiding pulleys the groove is made half round at the bottom, with the same radius as the section of the cord, as shown in the full size section, Fig. 22; and in the presser pulleys the bottom of the groove is rounded out with rather a longer radius, as shown full size in Fig. 23.

The cord is supported at intervals of 12 to 14 feet by fixed slippers of a plain trough section, in which it lies whilst running, as shown in Figs. 18 and 19, Plate 15, and Fig. 28, Plate 17. They are of cast iron, flat in the bottom which is $1\frac{3}{8}$ inch wide, and with side flanges, as shown in the full size section, Fig. 20; the ends are bell-mouthed, as shown in Fig. 19. These slippers are fixed $1\frac{1}{2}$ inches below the working level of the cord on the driving side, as shown in Figs. 18 and 28, so that the driving wheels pass clear above the slippers in the traversing of the crane, and lift a portion of the cord out of them successively in passing.

In experiments made with a number of slippers carrying different weights the friction between the cord and the slipper was found to be about two-fifths of the load; but as the total weight of that portion of the cord which rests on slippers is only 50 lbs. and the whole friction consequently amounts to only 20 lbs., it is not considered worth while to complicate the system by the introduction of pulleys for supporting the cord. No care in oiling is required as regards these bearing slippers used in transmitting the power along the shop, as is the case in the power cranes driven by continuous longitudinal shafting where tumbling carriers are required, or where heavy cords at low velocities are used, requiring carrying pulleys, the bearings of which need regular oiling. By means of pull cords passing from end to end of the shop, the main driving gear for each pair of traversers can be stopped at any time by the men working the traversers; so that when the cranes are not working, the whole of the high speed gearing stands idle.

The diameter of the worm wheel U of the lifting gear in the 25 ton traversers, Fig. 14, Plate 14, is $24\frac{1}{2}$ inches at the pitch line, and this is driven by a worm 3 inches diameter at the pitch circle with 1 inch pitch, the inclination of the threads of the worm to the axis of the worm wheel being 1 in $9\frac{1}{2}$ (1 in 9·4). This is found to be safely within the angle of friction, so that the worm will not slip back with any weight that it has to lift; and it thus affords a complete means of holding up the weight at any point without the use of a break, and of lifting or lowering it instantly without the slightest jerk. The pitch of the worms has however been so arranged that in lowering but little power is required further than to put the gearing in motion. The speed of the worms at the pitch line is 833 feet per minute for the lifting gear of the 25 ton traverser, and 486 feet per minute in the jib cranes. The pressure on the teeth of the worm wheel in the traverser, when lifting the maximum load of 25 tons, is $9\frac{1}{4}$ cwts.; and in the jib crane, when lifting the load of 4 tons, it is $7\frac{1}{2}$ cwts. In the practical working of the 25 ton traversers however the strain seldom exceeds one half the above amount, since in lifting locomotive engines the two crabs are usually employed in conjunction, for facility in slinging the engine.

The action of these cranes is very smooth and easy, and all the movements are readily under control.

Mr. Ramsbottom showed one of the cast iron slippers for carrying the driving cord of the crane, together with a piece of the cotton cord employed for the purpose, and also a piece that had been working on the 25 ton crane; it had not been in use many months, but was calculated from present experience to last about eight months before requiring renewal.

The Chairman enquired how long the cranes had been in use, and what was the reason for making the traversing cranes with wood trussed beams instead of wrought iron girders.

Mr. Ramsbottom replied that the jib crane in the wheel shop had been in use three years, and the traversing crane about four months. The traversing cranes were made with wood trussed beams merely to correspond in character with the cranes already employed in the shop. If all the cranes had now to be constructed afresh, no doubt iron would be used throughout in preference to wood. One point of great importance to the success of the crane had been to ensure all the pulleys being completely in balance, that they might run perfectly smooth and steady at the high velocities at which they had to be driven. This was done by balancing them carefully on a pair of parallel straight edges, adjusting their weight by a little filing and scraping, till they would remain at rest in any position indifferently, and when so adjusted they worked with great smoothness and steadiness. Without this complete balancing of the pulleys, the crane would have been a failure. In the jib cranes the driving pulleys of the lifting motion made as much as 1000 revolutions per minute; and it was by that means that the required power was obtained from so light a driving cord, and by simple contact of the cord with the pulleys, without its taking a turn round them. The friction cones for the travelling movement were made with hard wood surfaces, which were found to give a better bite than metal on metal; and there had been no difficulty in transmitting by them the full power required.

Mr. J. FERNIE had had an opportunity of seeing the cranes in use, and was greatly pleased with their construction and action. The jib crane was most convenient for taking a pair of wheels out of the lathe and conveying it to any other spot with the least possible trouble; and the traversing crane also was of great advantage for lifting an entire engine and shifting it from one line of rails to another. He enquired whether any provision was made for preventing the driving cord from slipping off the several pulleys over which it passed, and whether any accident had occurred from that cause or from the rope breaking.

Mr. RAMSBOTTOM replied that one accident had occurred with the 6 ton crane in the boiler shop not long after it began to be used, in consequence of the driving cord slipping off one of the pulleys, and sweeping the man off the crane platform. Now however guards had been added to the pulleys, as shown in the drawings, to catch the cord in the event of its slipping off, so as to prevent such an occurrence happening again.

The CHAIRMAN enquired what saving in labour had been effected in the wheel shop by the use of the new crane in place of the ordinary cranes used for such purposes.

Mr. RAMSBOTTOM replied that there were previously two dozen pairs of blocks and ropes employed in the wheel shop, requiring a large number of labourers to work them; whilst now the two traversing jib cranes alone, with two men to work them, did the whole work of the shop and very much quicker than before; and £300 a year was saved in the piecework prices of the work done in that shop alone by the use of the new cranes.

The CHAIRMAN asked whether any difficulty had been found from the dust of the shops acting upon the cotton driving cord.

Mr. RAMSBOTTOM replied there had been no difficulty from that cause: the cord was rubbed over at first with a little tallow and wax, and gave no trouble afterwards. It had been a question requiring some consideration in the first instance, what material should be used for the cord; whether leather, cotton, catgut, or hemp. He thought however nothing was so suitable for the purpose as a good cotton rope, properly made, on account of its lightness and suppleness. In using catgut the hook and eye forming the joint would give a very objectionable blow in passing over the pulleys at the high speed of running that was required.

Mr. R. WILLIAMS asked whether there was any difficulty in splicing the cotton rope.

Mr. RAMSBOTTOM had not found any difficulty arise in splicing the cotton rope: in cotton spinning machinery it was regularly done, and a good workman would make a splicing which could scarcely be distinguished from the body of the rope itself.

The CHAIRMAN enquired whether there had been any trouble with the slippers in which the driving cord was supported between the pulleys; and what form of slipper had been found best.

Mr. RAMSBOTTOM said he had first used a brass slipper, made narrower at the bottom than at the top and not giving the cord much room to play; but that shape did not answer, as the metal was found to become cut away too rapidly. Now however the slippers were made wider and flat bottomed, giving the rope free play, as it was found not at all necessary to confine it laterally. The metal now employed was also cast iron with the surface chilled, the chilled surface being smooth enough without any polishing: the friction was also less than with brass slippers.

The CHAIRMAN enquired whether the 25 tons load was allowed to descend freely in lowering the crane, and how the speed was checked in its descent.

Mr. RAMSBOTTOM replied that the load descended by its own weight after being once started, and the speed was checked simply by applying the driving cord to the pulley of the winding drum, when a very slight pressure of the cord in the V groove of the pulley was sufficient to control the motion.

The CHAIRMAN enquired whether any experiments had been made to ascertain the actual friction of the crab in the traversing crane.

Mr. RAMSBOTTOM replied that he had tried experiments upon the friction of the crab by attaching a small cord to the driving pulley, giving it a few turns round the pulley and carrying it over a fixed pulley so that weights could be hung on. It was then found that with a load of $8\frac{1}{3}$ tons on the crab it required 17 lbs. weight at the driving pulley to start this load in raising it. The theoretical power required at the driving pulley to balance the load of $8\frac{1}{3}$ tons was 6 lbs., showing that the friction of the worm and the rest of the gearing was 11 lbs. in that case, or nearly twice the theoretical power. The greater friction of the new crane as compared with ordinary cranes was indeed its only drawback; but that was more than compensated for by the simplicity of construction of the new crane, and the fact that in consequence of this increased friction it required no break to hold the load, which was an important advantage over the old cranes. Moreover if the cord were driven at a much lower velocity, in order to reduce the friction by diminishing the multiplying power of the crane, it would be necessary to put a much higher tension upon the cord, which would then have a tendency in the present arrangement of the driving gear to throw the crane out of line and cause it to run off the rails. It was therefore important to adhere to the high velocity of driving cord that had been already adopted.

Mr. E. A. COWPER observed that a light driving cord was the only plan compatible with a high speed of driving, as a heavy cord or chain would soon wear out by its own weight. The mode of reversing the motion, by merely deflecting the driving cord into one or other of the two grooves of the driving pulleys, was exceedingly simple and efficient; and the arrangement was also very simple for increasing the length of surface of contact of the cord with the pulley to meet the requirements of a heavier load. He enquired whether the weight of 17 lbs. at the driving pulley in the experiment that had been described was sufficient to start the crane.

Mr. Ramsbottom replied that the weight of 17 lbs. at the driving pulley of the crane was just insufficient to start the load of $8\frac{1}{3}$ tons on the crab from a state of rest, but if once started it would keep it going, the theoretical force required to balance that load being only 6 lbs.

Mr. E. A. Cowper remarked that the friction of the crane in the experiment was illustrated by the skidding of an engine on the rails when the wheels had once started slipping; and probably in the case that had been described the actual friction of the crane when once in motion was not much more than 6 lbs. in addition to the theoretical power required to balance the load of $8\frac{1}{3}$ tons; while from that force, 12 lbs., up to 17 lbs. at the driving pulley the crane would either run or stand. He enquired whether the jib cranes in the wheel shop were balanced by a load of ballast on the tail of the crane.

Mr. Ramsbottom replied that the jib cranes were not counter-balanced, the weight of the frame itself being sufficient to steady the crane under the heaviest loads it had to lift.

Mr. E. H. Carbutt enquired whether the cranes made much noise in working, on account of their high speed. He had seen a crane of similar construction at work in a foundry, and the noise it made was very objectionable.

Mr. Ramsbottom thought the noise in that case must have arisen from a want of balance in the moving parts; but in the present cranes, with the driving pulleys all properly balanced, there was no objection from noise, the cranes working very smoothly and quietly.

The Chairman proposed a vote of thanks to Mr. Ramsbottom for his paper, which was passed.

The Meeting then terminated.

Fig. 1. *Transverse Section of Engine Repairing Shop.*

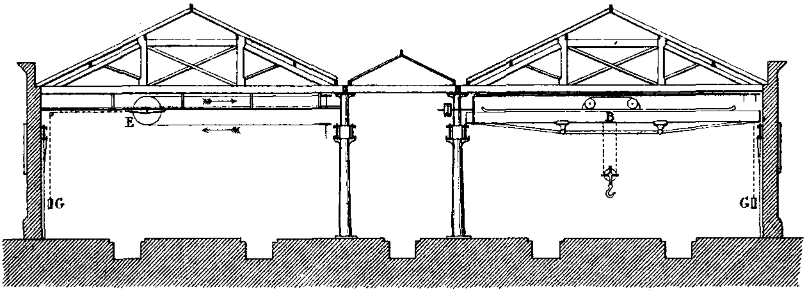
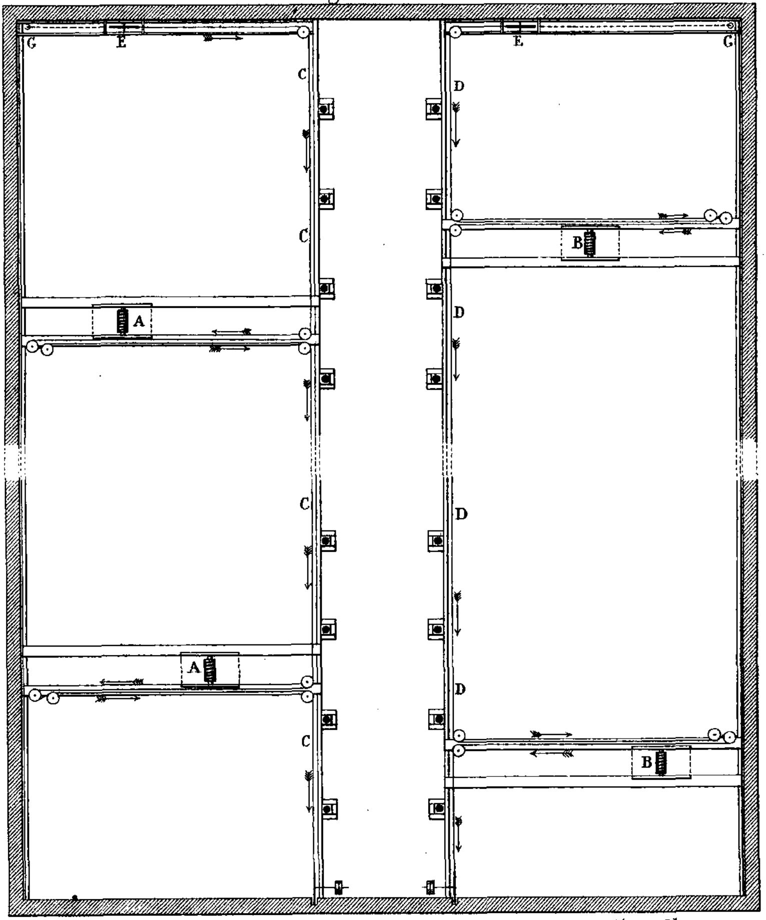


Fig. 2. *Plan.*



(Proceedings Inst. M.E. 1864. Page 44.)

Scale 1/320th.

0 5 10 20 30 40 50 60 70 80 90 100 Feet.

OVERHEAD TRAVERSING CRANE.

Fig. 3. *Side Elevation of Tightening Pulley for Driving Cord.*

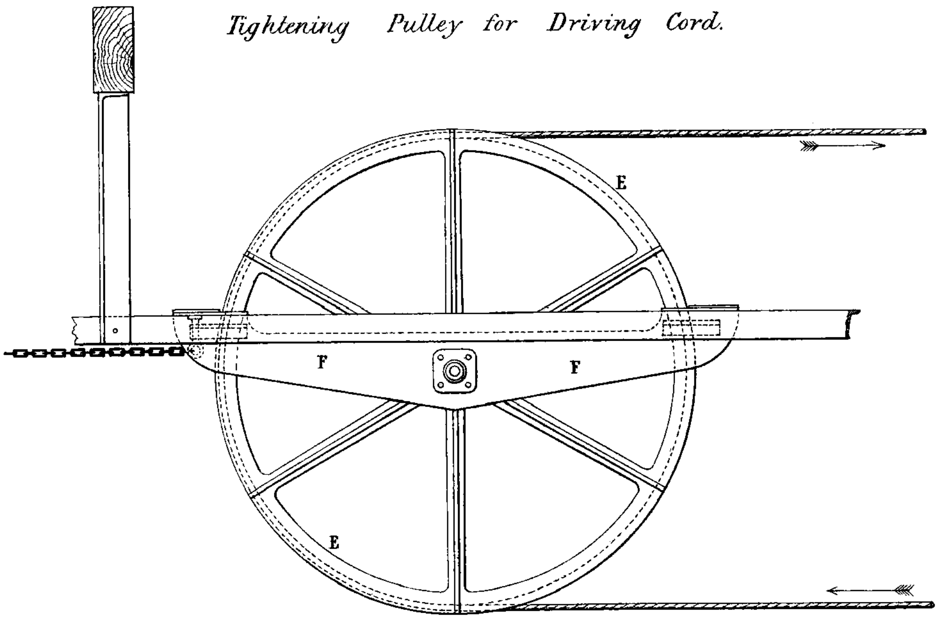
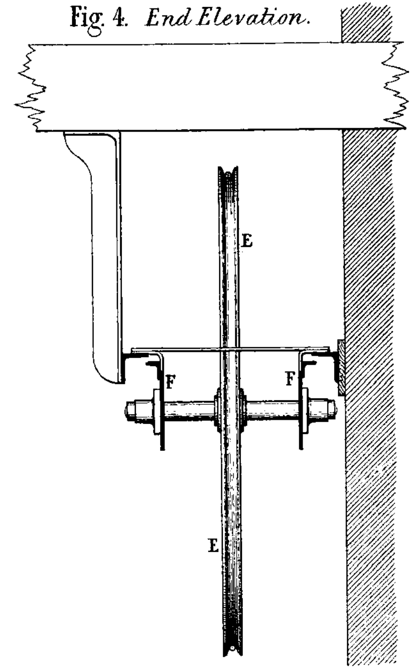


Fig. 4. *End Elevation.*



Scale 1/20th. 10 5 0 10 20 30 40 50 60 Inches.

(Proceedings Inst. M. E. 1864. Page 44.)

OVERHEAD TRAVERSING CRANE.

Plate 11.

Fig. 5. *Side Elevation of Traverser.*

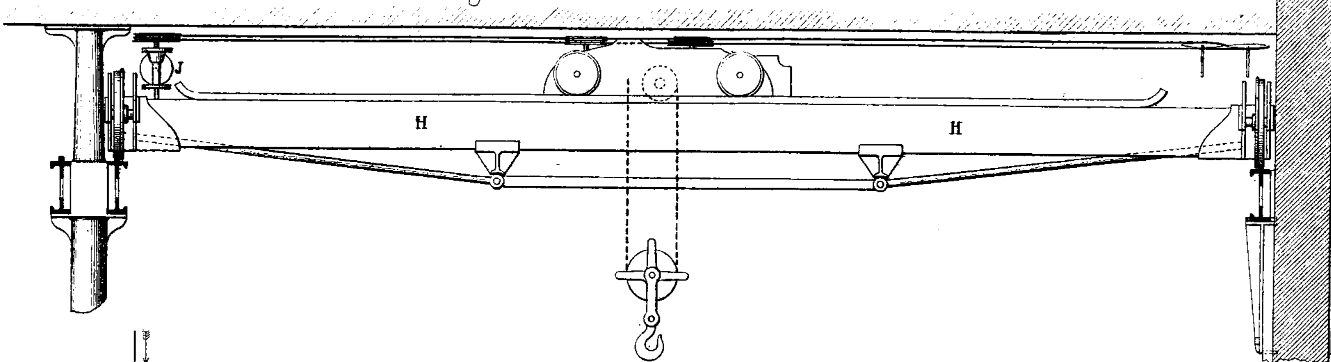
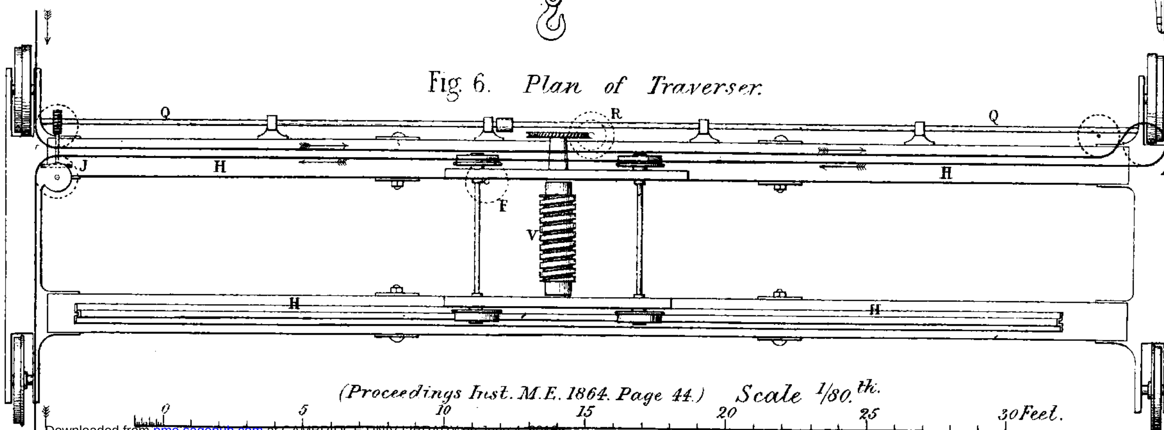


Fig. 6. *Plan of Traverser.*



(Proceedings Inst. M.E. 1864. Page 44.) *Scale 1/80.th*

Fig. 7. *Transverse Section at end.*

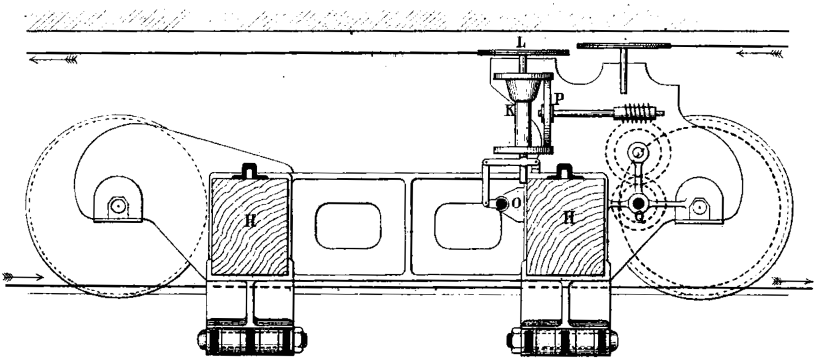


Fig. 8. *Transverse Section at centre.*

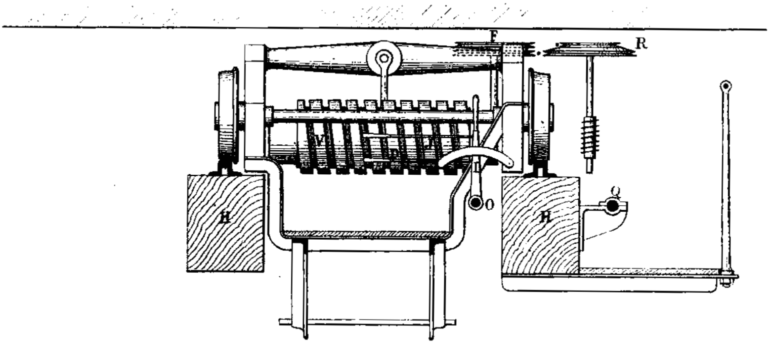
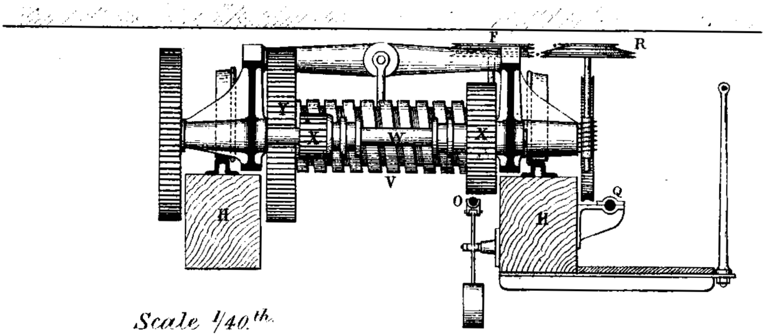


Fig. 9. *Transverse Section at centre.*



Scale 1/40th.

0 1 2 3 4 5 6 7 8 9 10 11 12 Feet.

OVERHEAD TRAVERSING CRANE. *Plate 13.*

Fig. 10. *Longitudinal Section of Crab.*

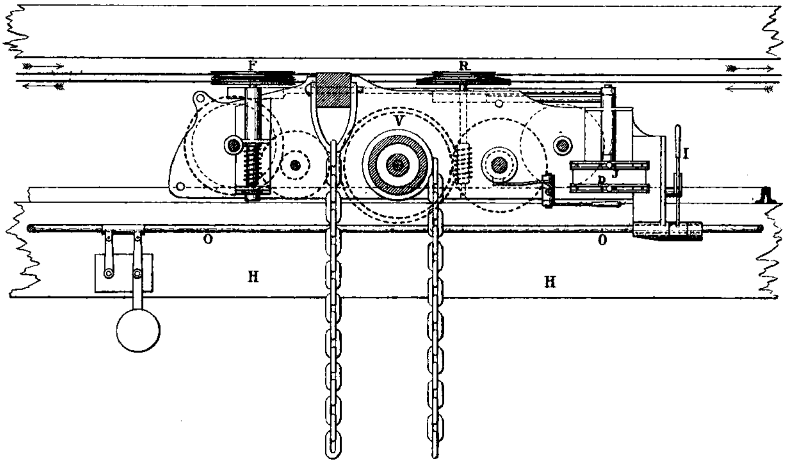


Fig. 11.

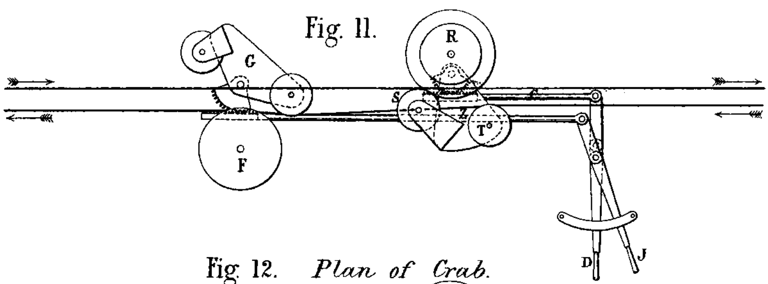
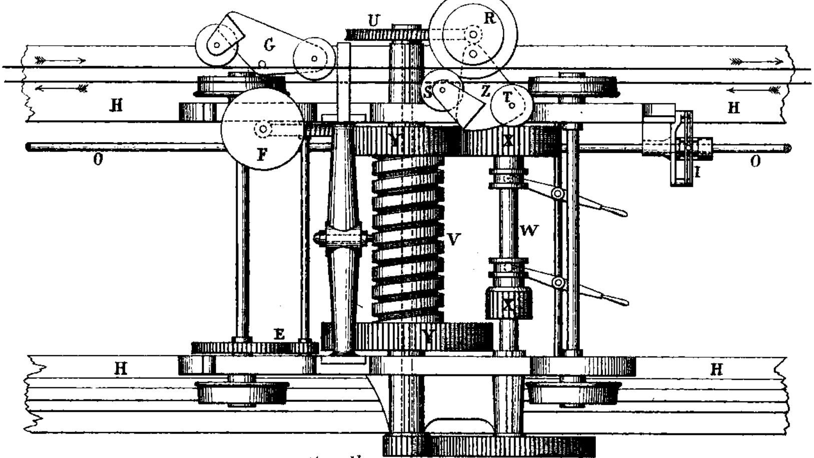


Fig. 12. *Plan of Crab.*



Scale 1/40.th

0 1 2 3 4 5 6 7 8 9 10 11 12 Feet.

(Proceedings Inst. M.E. 1864. Page 44.)

OVERHEAD TRAVERSING CRANE.

Plate 14.

Fig. 13. *Longitudinal Driving Gear.*

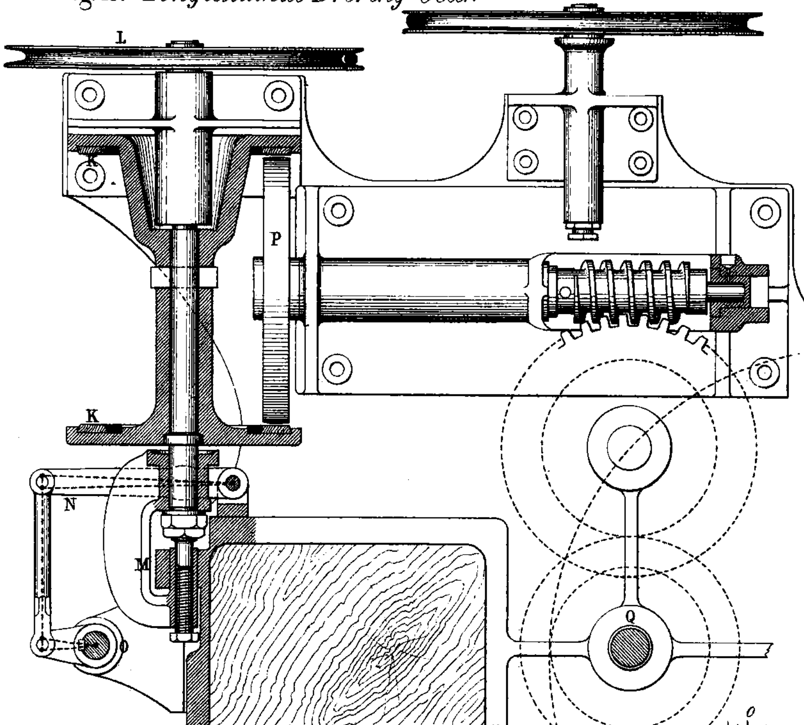


Fig. 14. *Lifting and Lowering Gear.*

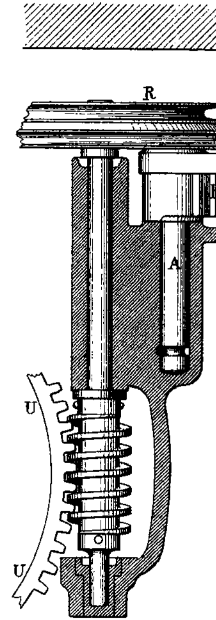


Fig. 15.

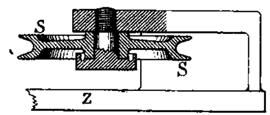
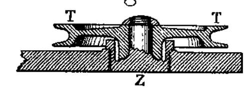
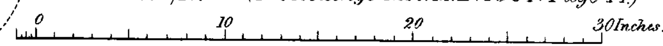


Fig. 16.



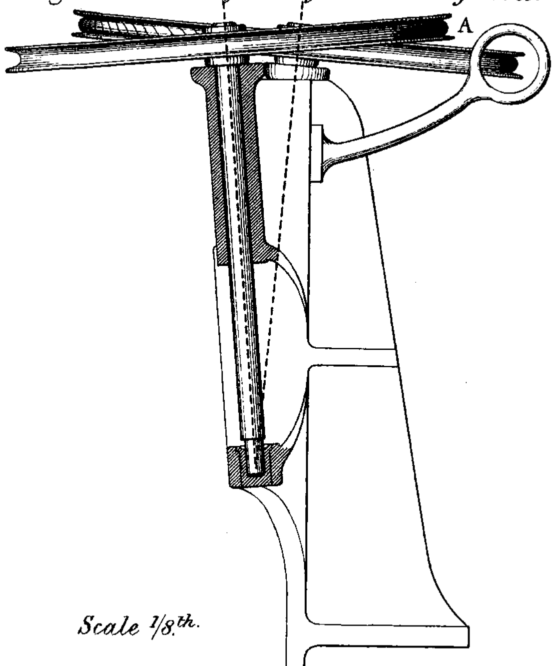
Scale 1/10th. *(Proceedings Inst. M.E. 1864. Page 44.)*



OVERHEAD TRAVERSING CRANE.

Plate 15.

Fig. 17. *Returning Pulleys of Driving Cord.*



Scale 1/8th.

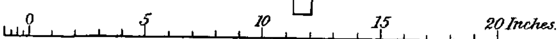
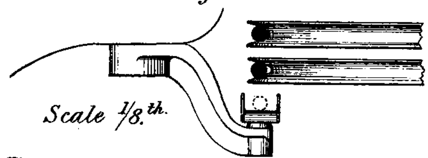


Fig. 18. *Slipper supporting Driving Cord.*



Scale 1/8th.

Fig. 19. *Longitudinal Section of Slipper.*

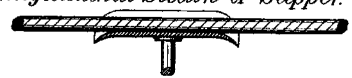
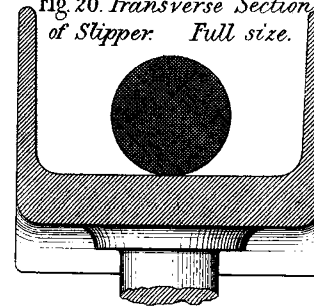


Fig. 20. *Transverse Section of Slipper. Full size.*



Full size Sections of Grooves of Pulleys.

Fig. 21. *Driving Pulleys.*

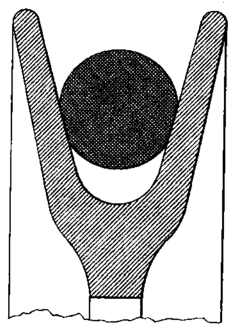


Fig. 22. *Guiding Pulleys.*

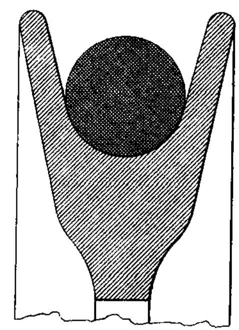
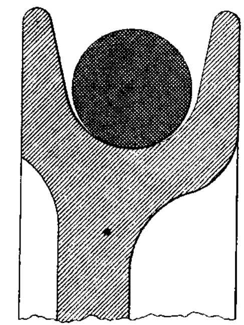
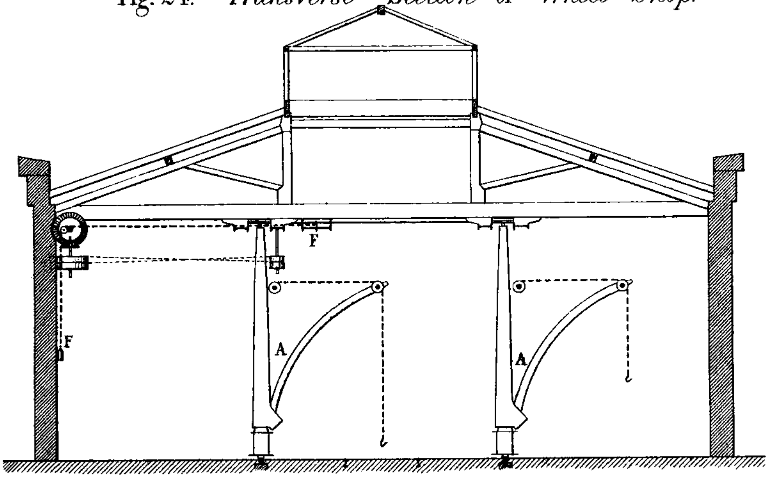


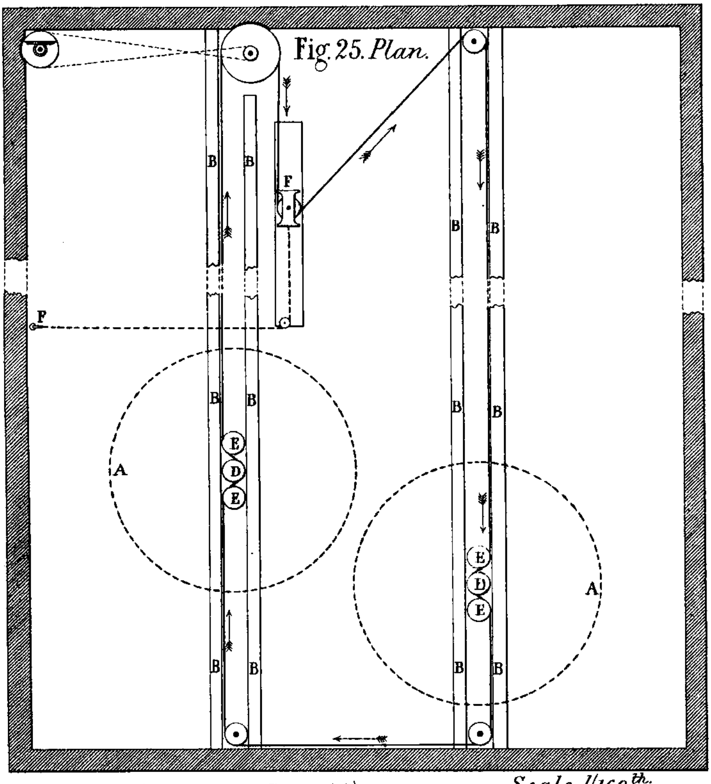
Fig. 23. *Presser Pulleys.*



(Proceedings Inst. M.E. 1864. Page 44.)

Fig. 24. *Transverse Section of Wheel Shop.*





(Proceedings Inst. M. E. 1864. Page 44.)

Scale 1/160th.

10 5 0 10 20 30 40 Feet.

TRAVERSING JIB CRANE.

Plate 17.

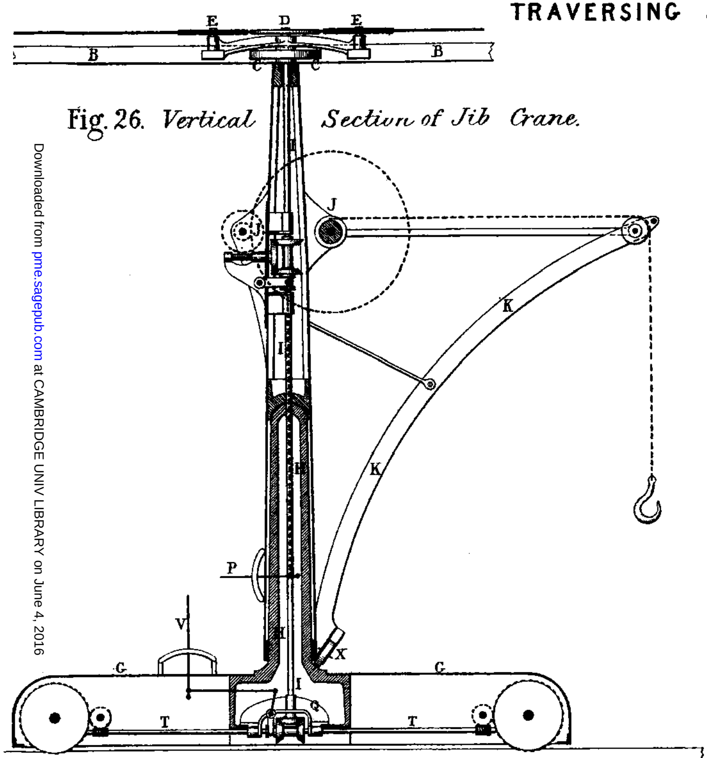


Fig. 26. *Vertical Section of Jib Crane.*

Scale 1/50th.

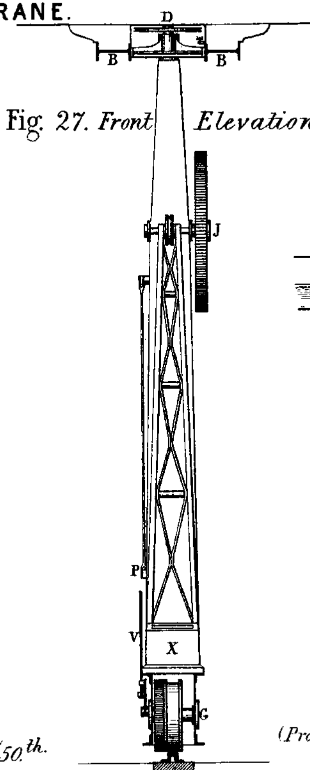


Fig. 27. *Front Elevation.*

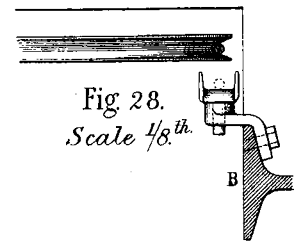


Fig. 28.
Scale 1/8th.

(Proceedings Inst. M.E. 1864. Page 44.)

0 10 20 30 Feet

Fig. 29. *Elevation of Lifting and Lowering Gear.*

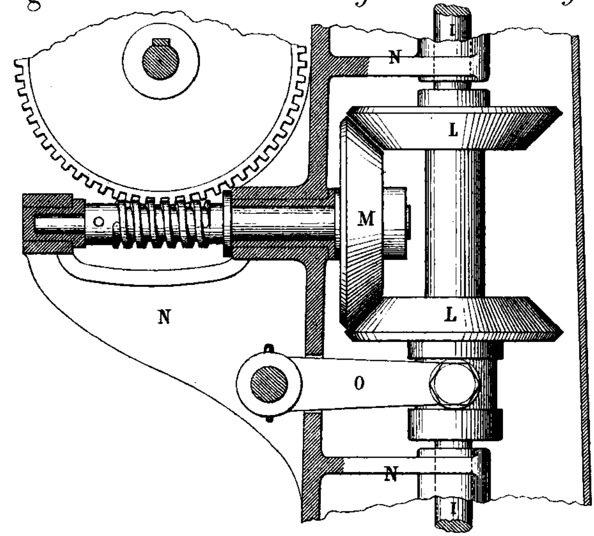


Fig. 30. *Sectional Plan.*

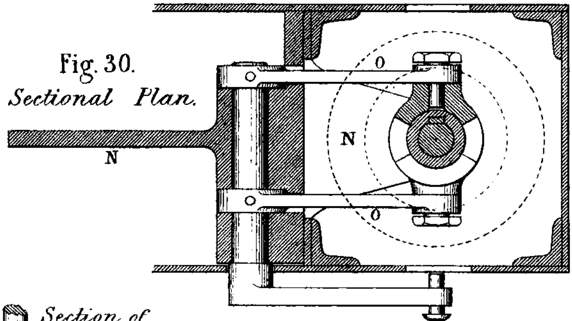


Fig. 32. *Section of Driving Cone of Traversing Gear.*

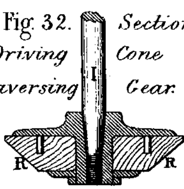
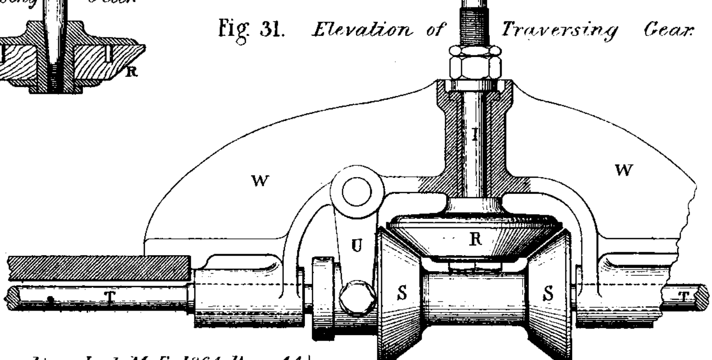


Fig. 31. *Elevation of Traversing Gear.*



(Proceedings Inst. M. E. 1864. Page 44.)

Scale 1/8 th. 0 10 20 *Inches.*