

Discussion.

Mr. Woods. Mr. E. Woods, President, said he thought the members would agree that the Paper gave a clear and concise account of the system of dealing with timber in the United States. The Author had described most ingenious appliances for dealing with timber with great rapidity. There was no doubt considerable waste of timber, but it was compensated by the rapidity and economy with which it could be rendered capable of being brought into the market. The rapidity of the motion of the saws was, he believed, greater than of any in this country. Working out the figures, he found that in the case of the circular-saw the velocity of the circumference was as much as 120 miles an hour, and in the case of the band-saw 85 miles an hour.

Mr. Robinson. Mr. THOMAS N. ROBINSON observed that some years ago he had visited the districts of Michigan and of Ottawa, and had seen the process of timber conversion as it was then conducted. He was much pleased that the band-saw was now making some progress in the Michigan district. When he was there he was greatly impressed with the enormous waste occasioned by the circular-saws, which were then almost entirely used for converting the timber. Almost every mill had a large furnace attached, something like a foundry cupola, for burning the saw-dust, and notwithstanding this the whole country round was almost buried in saw-dust. In the Ottawa district the management seemed to be much better. The lumber was sawn almost entirely by means of a vertical saw-frame, carrying a number of saws. The logs after being drawn up into the mill were passed through a chain-feed saw-frame by which the outside slabs were cut off, leaving the middle part wide enough to be sawn into deals; they were then passed through roller-feed frames and cut up into deals, and then on to the cross-cut saws, and to the loading place or stack-yard. The action throughout the mill was continuous, and in that respect had an advantage over the American circular-saw system, where the log was run backwards and forwards for slabbing. Cutting by frame-saws was nothing like so quick as with circular-saws, but fewer men could work them; two men could work two frames. By that means with the same amount of labour nearly the same quantity of work could be accomplished. The band-saw he thought was almost a novelty in America, not having been yet largely adopted. No doubt the Americans had made vast improvements on the European system in band-saws. One of the greatest im-

provements, which had made possible a much higher speed in Mr. Robinson. cutting, had been the adoption of large band-saw pulleys enabling them to use stouter and stronger saws. In Europe the French had been particularly famous for the use of band-saws, but they had never adopted pulleys of anything like so large a size as the American pulleys. The tension was also an important point with band-saws. If a saw was at all slack it was liable to cut crooked. The Americans said that it was not desirable to put on more tension than necessary. His own experience of band-saws was that a great amount of tension was required in order to cut straight, and to stand high tension a very good saw was needed. No doubt the American saw-makers had assisted the lumber-cutters in rendering the band-saw successful, by studying the question of making saws well, tempering them carefully, and using first-rate material. He thought it would be very desirable to introduce the band-saw in this country if people could be taught to treat it properly. The great thing to secure success was to keep the saws in good order. The operation of handling them was one which required considerable skill. He was pleased to hear that there was a probability that the valuable timber in America would not be wasted so much as hitherto by the operation of the circular-saw.

Mr. M. POWIS BALE asked the Author if he could give any Mr. Bale. information with regard to the back thrust of the saw, which he thought was an important point. The guides above and below the cut were also a matter of considerable importance. With regard to the question of novelty, he had himself superintended the manufacture of a machine for sawing deals twenty years ago; but it had not made much progress. There were now machines in England carrying two band-saws instead of one, and therefore cutting two deals at the same time. They might be seen at Bristol, Exeter, and other places. He agreed that the band-saw would rapidly supersede the circular-saw, when the prejudice against the former was overcome. The first point in regard to the working of band-saws was the shape of the teeth, according to the kind of wood cut. Some English band-saws were run off too thick a gauge and the wheels too small, consequently the arc of contact was too acute, and they broke, and thus band-saws had been condemned to a large extent. The question of speed was also an important one, and then there were the questions of set, the mounting of the saw, and various other matters in working that a clever workman could overcome. For sawing valuable wood the saving was very great. Of course the speed of production was not

Mr. Bale. so high as with a circular-saw, but there were compensating advantages. There was a machine in operation in Staffordshire, and he had another in the course of construction, in which the circular-saw, or rack-bench, as it was called, of large size, was combined with the band-saw. Either of the two could be used when required, and the same table was employed for the circular-saw and for the band-saw. The timber of this country was not, as a rule, as large as that of America, and therefore he was afraid that the combination would not have a large sale; but he thought it was worthy of attention in the United States. It was not quite clear whether the Author had brought forward all the machines illustrated as American novelties. In any case it might be as well to say that the so-called "American rack-bench," running two saws in the same vertical line, was of distinctly English origin, having been invented and patented by Messrs. Sayner and Greenwood in 1824. The plan mentioned in the Paper for drawing back the saw blades of vertical frames, so as to allow the teeth to clear themselves from saw-dust, was also old, having been invented by Mr. Thomas Greenwood, of Leeds, some thirty years ago. Descriptions of both these would be found in a book by Mr. Bale on "Wood-working Machinery," published in 1880. The steam nigger and trimming machine described were undoubtedly new as far as this country was concerned, and exhibited well the point to which labour-saving as regarded wood conversion had been carried in America. The conversion of logs by means of band-saws had been carried on with success in France for the last twenty years. The chief difficulty had been in keeping the saw in a true vertical line; this had, however, been got over by introducing guides immediately above and below the cut, and by the use of deflecting guide rollers. In comparing American circular-saws and band-saws, in both cases there was a practically continuous cut; but for the circular-saw could be claimed a much larger output, though at the cost of a greatly increased expenditure of power and waste of wood. The question therefore arose, Which system was the best adapted for English users? Although the average thickness of circular-saws in use here was about half the thickness of those generally employed in America, he thought eventually band-saws would gradually supersede large circular-saws for breaking down logs and sawing valuable woods. For sawing tolerably hard woods with a band-saw, all that was required was a reduction in the speed of the saw and the feed of the wood, and an increase of the number of teeth points to the inch, and these should also be filed further back. It might not be generally

known that larger band-saws than that described in the Paper Mr. Bale. were in use; he had seen one at work in Brussels passing through three floors of a building, with a table and an operator on each floor. He thought that the chief reasons why band-saws had taken so many years to develop in this country were due to natural conservatism, and the difficulty, at one time, of obtaining good saws; but given a well constructed machine, run at the proper speed, a careful operator, and a saw-blade uniform in gauge, width, toothing, sharpening, setting, and temper, and he believed the band-saw would prove one of the most money-earning and valuable of all wood-working machines.

Mr. J. B. MEREDITH desired some further information as to the Mr. Meredith. quality of the work turned out by the band-saw, and asked if the boards, before coming into the English market, were not planed on both sides. The reason for the great difference in American and English machinery was, he believed, the great cost of the latter. Some years ago a gentleman from America, in going over his saw-mills, remarked that the timber frames were got up to such perfection, that they would be far too expensive for ordinary use in the United States. It might be that there was some advantage in regard to economy and power, but he thought not. The trouble of band-saws was with regard to brazing and then breaking them. This would constantly happen, notwithstanding every precaution. He admitted that vertical-saws with timber frames were much slower in cutting; but then a great number of boards were cut at once, while the band-saw would only cut one board at a time. In the long run he thought that the timber frames of this country would beat the band-saws of the United States. The Author had stated that for the conversion of pine logs the balance of advantage lay with the band-saw, and added, "If this is so in the case of comparatively small and cheap timber, it is certain that for the more valuable descriptions of hard woods, which frequently run to very large sizes, these advantages would be enormously increased." He questioned that very much, because he thought that the low speed at which hard woods would be cut would almost throw the band-saw out of operation altogether. He also questioned whether there was as much waste of time by the use of the frame vertical-saws as there was in the case of band-saws. The point was a nice one, because he observed that the gauge of the saws would be nearly the same. He should like to know something about the cost of the machinery, as that was really the turning-point.

Mr. J. B. HUNTER said that six years ago he had read a Paper Mr. Hunter.

Mr. Hunter. on a cognate subject before the Students of the Institution,¹ in which he expressed his preference for American wood-working machinery. He was very glad to find that the Author, after a visit to America, entertained similar views to his own. He could not agree with Mr. Meredith that the progress made was due to the great difference in the cost of the machines; it was, he thought, rather due to the fact that in America timber was far more abundant, and that therefore there was a greater incentive to improvement. Any unprejudiced person comparing the wood-working machines of the two countries would, he thought, admit that the Americans had far surpassed English manufacturers in the machinery that they turned out, in point of speed, and in the delicacy with which they treated the smallest details. About seven years ago, when he was with Mr. W. Adams, M. Inst. C.E., at Nine Elms, he was associated with the putting down of machinery in the saw-mill. Mr. Adams placed there a large circular-saw from an American manufactory, precisely like that described in the Paper. It appeared to be a beautiful instrument, and there was a simple method of setting up the timber to gauge size without making any measurement by the foot-rule, thus tending to accuracy of workmanship, and to an improved turn-out in the class of work. The superiority of American machinery was due more to that cause than to the mere matter of cost. With regard to circular-saws, and the fact of their being hammered so that they might be slack in the centre, with a certain amount of dish to enable them to stand up better to their work, the Author appeared to prefer that method to the English plan, and no doubt he was right. He had not, however, mentioned the saw used at Nine Elms. The dish was put in not by hammering, but by placing the saws upon a mandrel. Two disks, one concave and the other convex, were pressed down upon the saw while it was in the furnace, and they were heated in that way while the pressure was being brought upon them at the same time that they were made to revolve. The consequence was that the saw never lost its slack tension in the centre after its work, and that obviated the necessity which there was in the hammered saw, of rehammering to again bring it into a proper condition after a certain period of wear. He thought it was far better to strain band-saws by an arrangement of levers and weights than by a spring, because a more even tension could be maintained. With a spring

¹ Minutes of Proceedings Inst. C.E. vol. lxvi. p. 313. "Wood-Working Machinery as applied to the manufacture of Railway Carriages and Wagons."

the tension would vary as the saw got heated; and when increased Mr. Hunter. tension was put upon the saw, as it cooled it was liable to be damaged. Saw manufacturers should endeavour to arrive at some formula by which the strain put upon a band-saw should be referable to the limit of elasticity of the material, because if that was exceeded a strain was put on which was very liable to lead to its fracture. Of course it would have to be varied as the width of the saw decreased; still that could be done entirely with reference to the sectional area of the saw. As to the centre portion of the saw being hammered out, so as to throw the principal strains upon the outer edges, he wished to know whether that was not much affected by the sharpening process. It would, he supposed, necessitate a fresh hammering. The Author stated that the sharpening had to be done every two and a half hours, and the hammering every two days; and he thought it was a question whether that constant sharpening did not materially affect the economy of the turning out of the work. One of those big saws, with wheels 8 feet in diameter, and a length of about 48 feet, with 1½-inch pitch of teeth, had four hundred and sixteen teeth to be gone over, and that meant a considerable time and expense in sharpening. If the operation was repeated every two and a half hours, there would have to be a constant relay of saws, time would be lost during the change, and a body of men would have to be maintained constantly at work in order to keep the saws up to the mark. That, he thought, was an item to be taken into account in comparing the efficiency and economy of the band-saw with the circular-saw.

Sir FREDERICK BRAMWELL, Past President, said that a member of the Institution to whom, together with Mr. Meredith, he was apprenticed many years ago—he referred to Mr. John Hague—was amongst other things a saw-mill maker, and Sir Frederick Bramwell had, therefore, an early opportunity of being conversant with saw-mill machinery. His connection, too, with Fairfield Works under Mr. William Bridges Adams had given him similar experience. He had listened with much attention to the Paper, and he had been peculiarly struck with the extreme ingenuity of the “steam nigger,” one of the most extraordinary machines he had ever seen, with its combination of two cylinders, each competent to make its own independent motion, giving to the rack-rod at the top almost any kind of movement that might be desired—movements nearly as varied as those which could be got from the human arm. The automatic trimming-bench was also extremely ingenious, ensuring that the greatest length of plank should be

Sir Frederick
Bramwell.

Sir Frederick Bramwell. obtained without any adjustment by the hand of the person attending the machine. With those exceptions there was nothing of any striking novelty. The steam feed of the band-mill was, it was stated, equally applicable to circular-mills for log-sawing, but this feed could hardly be called novel. The longitudinal cylinder with steam applied to it was, after all, nothing more than a steam-fed cylinder in lieu of the hydraulically-fed cylinder which was applied by Bramah in the wood-working machine of the Carriage Department of the Royal Arsenal many years ago. Then it had been said that reciprocating mills were made—he had seen them so constructed at Ottawa—with a motion which would draw the teeth away from the wood, so as to imitate the action of two sawyers in a saw-pit. This was not new; moreover, he doubted whether it was needed. His impression was that in an ordinary saw-frame, although the frame and the saws moved vertically, yet the saws, being set at an angle, and not vertically, directly they rose cleared themselves from the timber and continued clear, the feed coming forward while they were rising. With reference to the question of the relative merits of the band-saw and the circular-saw, he thought it was very much the old tale; where the material was cheap, as a rule the work was bad. Where coals were cheap, there was bad engineering in regard to the economy of boilers. Where sugar was cheap, there were bad sugar-mills. Where anything was cheap, people disregarded it, and it paid them better to turn their attention towards putting out a large amount of work than to do the work with the utmost economy of material. Complaint could not be made of a man who set to work in that way, in order to get the best return for his capital. That, he thought, really lay at the bottom of the difference between the sawing in England and that in the United States. With regard to the band-mill, he might perhaps be allowed to say that when he was at Fairfield Railway-carriage Works forty-three years ago, he devised a means of making a tire without a weld, and he exhibited the old drawing of it at the meeting of the British Association in Birmingham, in 1864. He thought he had invented it himself, but, of course, some one was before him. It afterwards occurred to him that that was a mode of manufacturing a hoop by which an endless saw could be made. He thought a band-saw would be an admirable implement, and that he had himself invented it; but again he afterwards ascertained that in the last century some one else had invented the same thing, and that he had joined his saw by brazing. He understood it was asserted that endless-saws

made with brazing were better than those which resulted from making the steel by the continual-rolling process, which, however, he should have thought would have been a perfectly practicable process. But in 1843-4, at the Fairfield Works, he produced a drawing of a multiple band-saw for sawing logs. He had four saws upon pulleys of varying diameters, set at what was supposed to be the requisite distance apart. He introduced it to Mr. William Bridges Adams, who decried it, and said it was no good, and he therefore abandoned it. He was pleased to hear that at Bristol duplicate band-saws were at work, and he thought there could be no difficulty in making even three or four saws work together, and using them for log cutting. He thought there was very little question that they were better for the purpose than the somewhat rough-and-ready implement, the circular-saw. As to the necessity of frequent sharpening, it was true that the Author had spoken of the need of sharpening every two-and-a-half hours; but he did not refer to the need of sharpening the circular-saws. Sir Frederick Bramwell saw no reason why the teeth of the band-saw should wear more rapidly than those of the circular-saw, and he should have thought that there was as much need for sharpening in one case as in the other, unless indeed the instrument was used in what he might call a more brutal manner, being continued in use in the machine when the teeth were not in a condition to turn out the best work and to waste the least material.

Mr. E. A. COWPER thought that the arrangement described by the Author for bringing logs up to the mill was exceedingly good. The endless chain was a most efficient instrument in many other machines, and in the present case it seemed to be admirably placed. There was only one simpler plan of bringing logs up quickly, and that was the plan adopted in Rangoon, of two elephants going down into the water, one putting his tusks under one end of the log and the other under the other end, and then walking up the bank, piling the logs one upon another 8 or 10 feet high. That was a rough-and-ready mode of bringing the logs up to the saw-mill. There was a snatch-block and a heavy rope, and the elephant took hold of the rope and drew the log into the mill. With regard to fixing the log, there did not appear to be a full description of the operation in the Paper. A number of spikes or claws were forced downwards to catch hold of the log, and there were other claws upon another bar forced upwards catching hold of it the other way. That was necessary to prevent it rolling over when the first cut was made. When the first cut had been made and a slab taken off, the wood laid flat and all went on smoothly. The

Mr. Cowper. amount of work described as done was out of all proportion to the work accomplished in English saw-mills; the American mills cost more, but did more, than the English. This was chiefly effected by using enormous power; whereas in England 48 HP. was used on the circular-saw bench, in America the amount was 253 HP. Of course, the instrument might, as Sir Frederick Bramwell had said, be treated in a brutal manner, and driven through with blunt teeth; but it should be remembered that the teeth were $2\frac{1}{2}$ or sometimes 3 inches apart, and there was a pretty good accumulation of saw-dust in every tooth. He had sometimes tried experiments with fine teeth with which it was impossible to feed the saw at a high speed. The old plan of two circular-saws, one saw above the other, got through a very large log, although, of course, the line where the two cuts joined was almost sure to be irregular. With reference to the high speed spoken of by Mr. Meredith, for hard woods, there was the example of the ordinary English veneer-cutting machine, in which circular-saws 22 feet in diameter travelled at a high speed. With regard to the heating of the saw, he had heard of a plan in the United States, consisting of a very fine spray of water applied immediately under the bed of the machine to the saw, so that, as soon as the saw got warm by going through the wood it was cooled by the spray. The velocity was so great that the water was thrown off. The mode described by the Author, of dishing the saw, was a most elegant and effective plan. By dishing the saw it became flat, when the outside was heated by the work, and in that way all that was needed was accomplished by doing away with the necessity of packing to bring up the temperature of the centre of the saw to the temperature of the circumference. He wished to ask the Author whether, owing to the great stress on the saw, circular-or band-, it tended to deviate from the true line if it came into contact with a slanting knot. He thought there must be some such tendency, but if the saw ran very fast he supposed deviation did not take place to any great extent. He had a little misgiving about the steam-feed. It would be observed that there was a long steam-cylinder under the rollers, and a long piston-rod had hold of the carriage, and moved it forward. As long as there was a careful man at the steam-valve, and the resistance of the saw to prevent the log going forward, all was well; but if the saw failed, it seemed that the log would get out of control, and that the expansion of steam in the cylinder would send it flying. That was a little more dangerous than the endless ropes and gearing, which could be driven at any speed, when the friction-clutch could be

used if necessary. The method described of soldering the band- Mr. Cowper. saw was a very neat arrangement, and was likely to help the introduction of band-saws into this country. The first plan of riveting them together was a failure. Then there was a plan of forking one saw into the other, which had also been a distinct failure. By splicing them down and brazing them if the ends did not hold quite close, there was sufficient left in contact to give strength to the band. With regard to the engines, proprietors were generally loth to put down a 300-HP. instead of a 60- or 70-HP. engine, but the quantity of saw-dust and shavings from the saw-mill was amply sufficient to work the engine if economy were observed. If the consumption of coal was brought down to 2 lbs. per HP. per hour, the saw-dust and shavings would keep the whole mill going; it was not, therefore, a serious matter to have an excess of power because there was nothing to pay for coals. In America there were large buildings like cupolas to burn the wood and the saw-dust, in order to get rid of it.

Mr. J. F. CHURCHILL said he had had considerable experience in Mr. Churchill. saving very hard timbers, such as satin, manille, and ironwood, mostly used for public works, and the only saw that he had found really successful was the pillar-saw, which worked up and down. He had tried the band-saw and the circular-saw, but they would not answer for hard woods, and he was obliged to have recourse to frame-saws. When the saws became hot, a stream of water was turned upon them. They were set very close, and a great deal of timber was saved in that way. He considered that there was no saw equal to the frame-saw for hard woods.

Mr. HENRY MAUDSLAY could not think that Fig. 6 was correctly Mr. Maudslay. drawn. There appeared to be no method of escape for the planks cut off between the circular-saw and the frame. The end of the spindle that carried the circular-saw and the floor was not sufficiently high to carry the logs that would be brought to bear upon it, nor was it shown how the logs were carried to be drawn above the spindle. With regard to the band-saw, it should be remembered that all the timber cut was full of sap and water. That was perhaps one reason why the band-saw was kept at a proper temperature, so as not to be destroyed or to become too much heated. The difference between the materials carried out from a circular-saw or a band-saw, in the localities where timber was growing, was quite another question to be considered on bringing the material into the London markets to be utilized either for planks or for veneers. References to the early history

Mr. Maudslay. of veneering would no doubt be found in the Institution;¹ but he wished to mention the very large frame-saws that were built up of slabs of steel, fastened to a frame as made by Brunel and Maudslay, sometimes 9 or 10 feet in diameter. The teeth in this case had to do only with the very hard and dry material.

Mr. Ransome. Mr. L. H. RANSOME, in reply, said Mr. Robinson had spoken of the vertical frames used in Canada, and seemed to think them rather better than the band-saw. There was, however, an objection to the vertical frame that with it the log must be cut at once into planks, whereas with the band-saw a cut could be taken from the one side or from the other as desired, so that the wood was cut up to better advantage. The narrow French blades for small work were better than the American blades, and probably if there were a demand for wider saws the French would make them equally well; but as wide band-saws were only used in America, they had hitherto only been made in that country. With regard to the question of waste, he had seen at the saw-mills in America refuse-burners built for burning waste wood, made of wrought-iron 24 feet in diameter and 75 feet high, to which the refuse wood was constantly being conveyed by endless chains all the time the mills were running. Splendid wood was burnt in that way, there being no other way of getting rid of it. As to the back thrust of the band-saw, there was generally a plate put behind the packing-box to support the back of the blade. Sometimes a metal roller was used, but it was not good, as it tended to upset the back of the blade and widen it out. Mr. Powis Bale had stated that there was no novelty about the band-saw. That was true, but there was a novelty in using it as a substitute for the circular-saw for cutting logs, especially for sawing soft timber, and it was only last year that that question was really settled in America. Up to that time people had not made up their minds on the subject, but now the circular-mill owners were taking up their mills and putting band-saws in their place, and he imagined that they would not do so if it did not pay. Big wheels were, of course, one of the secrets of success, as otherwise it would be impossible to work saws of sufficient width to admit of rapid cutting. As to the quality of work turned out, it would be seen from the Paper that only $\frac{1}{32}$ inch was allowed on each side for planing, which proved that the work must be good. With the circular-saw $\frac{1}{16}$ inch was allowed. The reason why Americans

¹ "A Treatise on the Manufactures and Machinery of Great Britain," by Peter Barlow, 1836, p. 384; and Minutes of Proceedings Inst. C.E., vol. xvii. p. 17.

made cheap machinery was, that when an American had bought Mr. Ransome. a machine, if he saw anything better the next day he would buy it; but an Englishman wanted a thing that would last him for generations, anticipating that his grandchildren would use it as well as himself, and that was the reason why an English machine was made more perfect and cost more money. As to the question of breaking, brazing, and sharpening, one man with a machine was quite sufficient to keep saws enough going for a mill to cut 30,000 feet of timber per day. The sharpening of a saw took about an hour, and the brazing about the same time. Band-saws had been used in America for six or eight years for cutting hard woods, but of course they did not cut them so quickly as they did pine. For walnut wood 7,000 feet a day was considered fair work. He agreed that the gauge system of working was very good, and ought to be more generally adopted in this country. The "steam nigger" alluded to by Sir Frederick Bramwell, was certainly the most wonderful machine for handling logs. When seen from the upper floor of the mill, its action looked more than anything else like that of a human being, and a very strong one. As to the mode of fixing the logs alluded to by Mr. Cowper, there were two sets of jaws, one going up and the other down. When it was desired to fasten the rough side of the log, by putting the lever down completely, the jaws projected $1\frac{1}{2}$ inch; but for holding the flat sawn side of the log, the projection was reduced to $\frac{3}{8}$ inch. There were several teeth, and they held the log securely. He did not think there was much danger in the steam-feed, the sawyer soon learnt how to handle it gently and lightly. Occasionally men were thrown off the carriage, but they were rarely hurt. As to Fig. 6 referred to by Mr. Maudslay, he copied it from a photograph, which did not show the position of the log-carriage with regard to the saw.

Correspondence.

Mr. F. H. ANSON said that on the 8th of September, 1885, he Mr. Anson. had seen a double band-saw at Messrs. Sharpe's saw-mills at Exeter. It was in regular use, chiefly for reducing deals. At the time of his visit the work in hand was to put fourteen cuts in a set of deals, measuring approximately 11 inches by 3 inches by 12 feet long. Each deal was first sawn into five planks by two double cuts; then each of the five planks was sawn into three thin planks by one double cut. The cross-section of the deals