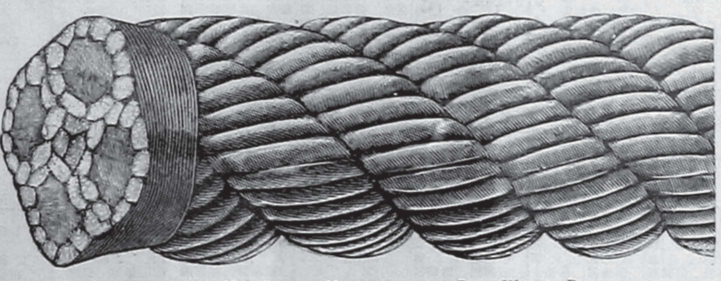
Machinery and Appliances.

INDIA MILL, DARWEN: CONVERSION FROM WHEEL GEARING TO ROPE DRIVING.

ENGINEERS: MESSRS. JOHN MUSGRAVE AND SONS, LIMITED, BOLTON; ROPE MAKER: MR. THOMAS HART, LAMBETH ROPE WORKS, BLACKBURN.

The traveller from Manchester to Blackburn who chooses the western route *via* Bolton, in passing through Darwen will, if on the look-out, have his attention arrested by a lofty, square, ornate tower, faintly recalling to his recollection the Victoria Tower of the Houses of Parliament at Westminster. If he is a stranger and enquires from some one better informed, he will learn that the structure is the chimney of the handsome mill close to which it stands, and that this is the celebrated India Mill, regarded as a model for architectural beauty and every excellence that could be embodied in a cotton mill at the time it was erected, which is about twenty-four or twenty-five years ago. And so far as could be seen at that time, it well deserved this repute. It was built by a well-to-do firm, that of Messrs. Eccles Shorrock and Company, which has since ceased to exist, but the founder of which was long known as one of the most shrewd and successful cotton spinners that the first half of the century had produced. The disastrous days of the cotton famine, however, came on during the time the erection of India Mill was proceeding, and pressed them heavily. The mill, however, was completed according to the original contract, and no money was spared to make it everything that could be desired. It was well fitted with boilers, engines, and gearing on the then best known principles. After being furnished with machinery and run for a few years it was disposed of about 1873 to a company, which has worked it ever since.



THE LAMBETH ROPE.—MR. THOMAS HART, LAMBETH ROPE WORKS, BLACKBURN.

Not much success had attended the working of the mill by its builders, and it fared no better in the hands of its new proprietors. The latter had acquired it at an unfortunate period for themselves, just on the eve of a considerable change in the method of transmitting the power from the engine to the machinery. The trying times of the cotton famine had led people to carefully overhaul each part of their establishments in order to effect every possible economy. In this process it was inevitable that the wastefulness, the cost of lubrication, the dirt, the noise, the breakages, and the risks of various kinds incidental to the working of wheel-gearing should come strongly into view. Previously to this time the exigences of the manufacturing industries in the United States had led to the extensive adoption of belt driving in that country. Efforts were then being made to introduce this system into England, and these were being attended with some degree of success. The quality of leather necessary for main driving belts and the high cost, together with several disadvantages not necessary to enumerate, rendered its general adoption difficult, whilst on the other hand it hardly promised adequate compensation for the change. But parallel with the development of belt driving in America, a new system was invented, or perhaps it would be more accurate to say revived, by Messrs. Combe, Barbour, and Combe, the eminent machine makers, of Belfast —that of transmitting power by ropes, and several small installations were put down by that firm in the north of Ireland, we believe mainly in the scutch mills there. An analagous requirement existed in connection with the Dundee jute trade, and this method was introduced into that district. As observed in a review in our last issue a small installation of the system was seen in the neighbourhood of Dundee by Mr. William Bamber, cotton spinner, of Bolton. This gentleman was so struck with the merits of the system that he at once determined to adopt it in a mill then being rebuilt after a fire. Messrs. Musgrave and Sons, the eminent engineers of Bolton, performed the work, and its merits were so great that Mr. Bamber was thoroughly well satisfied with it in every respect. The attention of the trade was drawn to the new system in an article in a technical journal by Mr. Richard Marsden with the result that its merits began to be widely discussed, and rope driving plant became in demand. It goes without saying that it was at first opposed as much as possible by engineers, and all sorts of trouble were prophesied as likely to fall to the lot of those who were foolish enough to adopt the system. To the best of our knowledge Mr. Goodfellow, engineer, of Hyde, was the first to make known his readiness to supply customers with the new system and to advertise the fact. It was soon afterwards adopted by other firms, and quickly became the most popular system. For the past twelve years hardly any other method has been selected for use in our cotton mills, notwithstanding the fact that, owing to the inexperience of makers, some difficulties were encountered with the earliest instances. Not only is this the case, but a considerable number of conversions from gearing to rope driving have taken place.

It is to a conversion of this kind, which has just taken place at India Mill, that we wish to draw the attention of our readers. As observed above, the mill was completed in 1867, and started, we believe, at the beginning of 1868, as well equipped as money and the then state of engineering skill could do it. The result has not been satisfactory, especially when it is considered that the mill had to work in competition with more modern mills arranged for very long mules and driven by ropes. The directors of the joint stock company that acquired it about 1873, and who have since struggled most bravely under adverse circumstances, were led to see that if they would prevent the entire loss of the shareholders' capital it was necessary that the system of driving should be entirely re-arranged. They therefore decided upon its conversion to the rope system. They entrusted Messrs. John Musgrave and Sons, the eminent engineers of Bolton, with the task, who undertook the work with their accustomed energy. New engines have been put in, and the old toothed gearing has been replaced by rope driving. The new engines are a pair of horizontal compound tandem type, capable when fully worked of turning a load of 2,000 indicated horse power, at a boiler pressure of 120 lb. per square inch. The present boiler pressure is only 80 lb., but it is intended at some future time to replace the present boilers with new ones to stand the higher pressure. The cylinders are 23-in. and 44-in. diameter, with a stroke of 6-ft. and the engines make 54 revolutions per minute. The cylinders are fitted with Corless valves, actuated by Messrs. Musgrave's latest patent valve gear, that of the high pressure cylinders being controlled direct by the governor, which is capable, in conjunction with the Higginson patent mercurial regulator with which it is fitted, of maintaining an absolutely uniform speed under varying loads. The crank shaft is of Siemens steel, the neck being 17 in. diameter by 34 in. long. The cranks are of hammered iron and are fitted with Siemens steel pins. Each engine is provided with a separate air pump of the usual vertical single acting type, driven from the crossheads by means of wrought-iron levers. The condensers are of Messrs. Musgrave's improved injector type. The frames are of very massive proportions—in fact the engines throughout constitute a very substantial job, and are pleasing to the eye. The flywheel is 30 ft. in diameter, prepared for 30 ropes cf 1¾ in. diameter. The speed at which the ropes travel is 5,100 ft. per minute. The wheel is built up in 24 segments, and has two bosses and a double set of arms—24 in number; the total weight of the wheel being 65 tons. The arrangements made enabled the engines to be erected ready for work before the mills were stopped, the time taken being eight weeks, very little overtime being worked. After stopping the mills the gearing alterations were carried out in the short space of 20 days, no Sunday time being employed. When it is borne in mind that his time included the taking out of the old gearing and shafting (75 wheels and 360 ft. of shafting, including two uprights), and revolutionising the whole of the driving arrangements—much cutting of solid ashlar walls being necessary—it will be admitted that the time taken was exceedingly short, and reflects great credit upon Messrs. Musgrave and Sons. It is perfectly safe to state that this s the largest conversion that h as been done in England, perhaps in the world. Messrs. Musgrave and Sons supplied the whole of the plans and quantities for the alterations, including those for the engine-house, which is in character with the architecture of the mills. The engine foundations are entirely of concrete. During the time which the engines have been running, though it has been too short to enable the reduction in the coal consumption to be ascertained, the conversion has proved highly satisfactory in every respect. Before the alteration five boilers were employed, with two firebeaters to keep them supplied with fuel; now only four boilers are needed, and one firebeater is sufficient.

India Mill contains 81,000 spindles, and the power is transmitted from the 30-feet rope wheel to five 7-feet pulleys by 30 Lambeth cotton ropes, 1¾-in. diameter, made by Mr. Thomas Hart, of the well-known Lambeth Ropery, Blackburn. This business establishment, one of the oldest, if not the very oldest, of its kind in Lancashire, having celebrated its centenary in 1889, was naturally called upon at an early period in the revolution in the driving system, as one of the most likely to supply the best ropes to meet the requirements of the new method of driving. The consideration Mr. Hart gave to the subject led to the invention and construction of the Lambeth driving rope, so called from the works in which it is made bearing that name and being situated upon an estate belonging to the Archbishopric of Canterbury.

The Lambeth rope is designed upon and

with due regard to strict scientific principles, and the requirements of the purposes for which it is intended. These purposes demand both a maximum of tensional strength and suppleness or flexibility. The first is needed in order that the ropes may bear the great strain involved in transmitting the amount of power they are called to deliver to the machinery in connection with which they are used. It is a well-ascertained fact that the strength of fibrous materials is not increased by torsion, much as the popular belief may run to the contrary. The strength of a single fibre of any material may be any given amount, and the strength of any number of them may be the multiple of the number, so long as the fibres are laid parallel to one another. But should they be twisted and then tested their united strength will be found to be much less. We need not go into an explanation of this fact; those who are curious upon it may find it fully given and details of tests in Dr. Bowman's work upon the Cotton Fibre, and a condensed statement of the same in Marsden's "Cotton Spinning." With the full knowledge of this fact Mr. Hart went to work and laid the cotton threads of the yarn parallel to form a strand. These were not twisted, in order that their tensional strength should not be reduced. This strand was then covered spirally by a twisted cord of cotton yarn which, not having to bear any strain, but only to act as a shield or guard to the core strand, could be made as firm as required to prevent wear by contact with the grooves in which it has to work. This covering, it will thus be seen, thoroughly preserves the working part of the strand—the core—from contact and wear in the grooves, whilst it wil be equally obvious that it does not interfere in the slightest with its flexibility. Three or four of these strands are next combined to form a rope according to the diameter required. Necessarily at this point little twist is needed.

The accompanying illustration is a very accurate representation of the Lambeth rope. This rope will work for years in a position where ropes on the ordinary construction would be almost pulverised by the alternate bending around the pulleys and the straightening out again. In tests that have been made it required a weight of 9,722 lb. to break one of 1½-in. diameter, which at that weight broke clear of its fastenings. With a strain of 2,000 lb. a similar rope stretched 5½ per cent., due to the elasticity of the cotton yarn of which it was composed. When the load was removed it returned to its original length. One of 1¾-in. diameter broke at a strain of 12,639 lb., and with a stress of 2,500 lb. stretched 7½ per cent., returning to its original length when relieved. As in the working the smaller, rope running at a speed of 4,000 feet per minute and transmitting 22 horse-power, has only a strain upon it of 182 lb., it will be obvious that no appreciable stretch does or can take place. As to durability, there are ropes that have been constantly in use for over seven years, and still appear as good as when first put to work. It will be obvious, therefore, from what has been said, that the directors of the India Mill have acted in making this conversion in a manner highly judicious and wise; it is one which they are justified in adopting in the interests of their company by scientific principles and the wisdom which is derived from the experience of other people.

We may conclude by saying that we have every confidence that both Messrs. Musgrave and Sons and Mr. Hart will be pleased to afford any further information that may be desired concerning their respective portions of the work done at India Mill.

ITALY is increasing her importations of raw jute in bales every year from India.

Bleaching, Dyeing, Printing, etc.

ALIZARINE DYES ON WOOL.

Much has been said about the alizarine dyes. Some parties who have never used them are contemplating making a change, and others who have used them in a limited way are frequently adding to their list of colours. There are now so many colours of the alizarine dyes that it is practicable for a mill to run on them alone.

Blackstone, in the *Boston Journal of Commerce*, writing on this subject, says:—I have had occasion to write in these columns commendatory reports in regard to these dyes, and now I think that for resistance to fulling, and the hot and severe steaming on the modern steam gig, they are ahead of anything I have used. I wish now to call the attention of dyers to the advisability of testing these colours, as well as others, in a thorough and common-sense manner before they pronounce them satisfactory. It seems to me that the proper tests to subject a colour to are the conditions under which it will be used after leaving the dyehouse, not only in its further progress through the mill, but outside of it, in the made-up garments on the wearer's back. A certain colour made by a given rule may be all right so far as the works are concerned, but when made up into a garment and exposed to the various changes in the weather, may not be so satisfactory.

Colours to be used in goods for men's wear should be made as thoroughly fast to changes caused by exposure to the weather as is consistent with the quality of the goods. And I am not sure that it would not be the best way to make all colours as fast as possible. We all know how badly a faded coat looks, and some of us how it feels, on a man's back. The fact that the fabric is made out of a low grade of stock, and is cheap, does not help the looks of the colour, or rather the want of colour.

Now, the principal test to be applied to a colour, after it has been found satisfactory in the works, is what might be called the weather test. This consists of exposing the coloured fabric or stock out of doors, where it will be subject to all the changes of this changeful climate—the heat of the sun's rays by day and the refreshing, but, I fear, colour-destroying, moisture of the dews by night, the storm, the wind, the gases, in fact every change and condition of the atmosphere.

From the first the claim has been made in a general way that the alizarine dyes were fast to fulling, soap, steaming, and light, and in many cases to acid and alkali tests. The claim, so far as the changes caused by the work in the mill, I believe to be well founded, but as to light or the weather test it ought to be qualified. There is quite a little difference in the appearance of a colour exposed to light simply, and the same colour exposed to light and atmospheric changes. Some colours will change as much when exposed out of doors a few days as they will when exposed to the light for a few weeks. Hanging the colour to be tested in a south window will do very well for a sun test, but for a weather test the colour should be placed on a board or something out of doors in such a place as to get the sun's rays on it all day long, and in as vertical a direction as possible.

Some dealers and some writers in trade papers claim that alizarine blue is as fast to light as vat-dyed indigo blue. Now I should like very much to make the acquaintance of a dealer or dyer who has such a blue. I have used several brands and I find little choice in them in that respect, they all being unsatisfactory. I have before me a sample of wool dyed with alizarine blue, about the shade of a light blue army overcoat. It looks well, and stands the wear and tear through the mill in good shape. A piece of the same wool hung up inside of a window with a south exposure, so that it gets all the sunlight that it can, changes a little in the first week, and after a couple of weeks, the change is considerable, while at the end of thirty days it looks quite faded. Take another example of the same lot of wool and give it the outdoor exposure; here the change will be quite rapid: in three days a very perceptible fading has taken place, at the end of ten days it would be difficult to convince one that it was originally blue, in fact, about the only thing blue about it is the dyer's feelings when he views his handiwork after having been dealt with by the kind and gentle forces of nature. In view of these facts the constantly reiterated claims for this colour in regard to stability to exposure are not only absurd, but positively irritating. How different the staying qualities of a vat-dyed indigo blue; months of exposure will not change it as much as days will the alizarine.

Let me give you a record of observation in regard to some other of the alizarine colours which I have used and tested by exposure to the weather in the past year; it may furnish some suggestions to others in regard to testing the colours which they may be using. To me the results have been a surprise, and I believe they will be so to others, on account of the claims which have been so persistently made for these dyes. Of the colours which I have tried the blue fades the most, while the red and orange shades stand the best, and brown and yellow come close together as to staying properties.

Two shades of alizarine orange, one a little fuller than the other, were tested. Mordanted with alum and tartar, the samples, after an exposure to the weather test for five days, shewed no perceptible change. After ten days the colour seems a little fuller, but there is so little change that it is hardly recognisable. The same dyes on a chrome and tartar mordant shew after ten days exposure a darker colour, with less bloom. Alizarine blue in light shades after ten days looks like a dirty grey; in full shades, as in navy blue, the body of the colour seems to stay, but the sample has lost in bloom. Alizarine brown, in light or dark shades, shews very little change after ten days' exposure. Galleine, light shades change considerable, though not as much as the blue; in dark shades the change is not so pronounced. In all of these colours the mordant has been bichromate of potash and tartar, except for the orange, where alum was used. The formula and directions of the makers were strictly followed.

PRINTING INSOLUBLE AZO-COLOURS ON THE COTTON FIBRE.

It is well known that up to the present time no one has been successful in fixing the azo-colours on the cotton fibre in a condition to resist soaping. From the time when the azo-colours by their brilliancy and fastness secured the favour of the wool dyer, they have resisted every mordant, organic and inorganic, to fix them on the cotton fibre, water alone being often sufficient to remove them, and to dissociate the most intense metallic precipitate which has been formed on the fibre. H. Koechlin has brought the question a step nearer solution by the discovery that mixed oxides, as for example alumina and magnesia, fix many colouring matters, such as Gallocyanine, much better than a single oxide, giving shades faster to washing. Koechlin treats the fibre with a mixture of alumina and magnesia salts, and fixes these by passing through a solution of zinc in soda, whereby a kind of triple mordant of alumina-magnesia-zinc is deposited on the fibre. The results are not altogether satisfactory, the shades lacking the necessary fastness to soaping, yet the progress already made warrants the hope that a mordant will be found which will fix the azo-colours on cotton. This method of making the azo-colours, especially the scarlets, useful to the cotton dyer and printer is much to be preferred to that of developing the colour direct on the fibre.

Turning now to the subject of producing the azo-colours direct on the fibre, the method suggested by Meister, Lucius, and Brüning is in reality identical with that of Thomas and Robert Holliday, of Huddersfield, whose first English patent is dated 6th July, 1880. This method is sufficiently practical to have secured adoption on a large scale both in France and