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XXXIX. *Description of an Improved Crane and Flexible Chains.* By Mr. GILBERT GILPIN, of Old Park Iron-Works, near Shifnal *.

HAVING discovered a method of working chains of the common construction, over pulleys, in all directions, more safe and flexible than the best hempen ropes, and at the same time equally uniform, I have sent, for the inspection of the Society for the encouragement of arts, manufactures, and commerce, a full-sized pulley in wood, and a piece of a chain, together with a model of a crane, exhibiting its manner of application.

From its simplicity of form, and facility of manufacture, the common chain, formed of oval links, has been in use from the earliest ages; and that it did not answer every purpose of a hempen rope, in working over pulleys, was not owing to its peculiar form, but from an error in the application.

Every chain of this nature has a twist in itself, arising from a depression given by the hammer to each link in the welding †; and this circumstance, so trifling in appearance, is not so in its effects, and it has in consequence a perpetual tendency (even when reefed perfectly straight in pulleys, and on the barrels of cranes) to assume a spiral form, which a plain cylindrical barrel, and the common pulleys with semi-circular grooves, are not in the least calculated to prevent. Hence the alternate links of the chain, in coiling round a barrel, or working over pulleys, form obtuse angles in assuming the spiral form, bearing upon the lower parts of their circumferences, and forming as it were two levers, which wrench open and crush each other in proportion to the weight suspended, as well as prevent the freedom of motion in the links themselves, and thereby load the chain with additional friction.

* From *Transactions of Society of Arts*, &c. 1806. The silver medal of the society and 30 guineas were voted to Mr. Gilpin for this invention; and models of the crane and chain are reserved in the Society's Repository, for the inspection of the public.

† The twist may be seen by holding the piece of the chain by one end, and viewing the links edgeways as it hangs down.

A still

A still greater obstruction to the uniformity of its motion, is the tendency which the chain has to make a double coil as it approaches the middle of the barrel and crosses its centre, and that of the pulleys at right angles, by means of which the chain is frequently broken by the sudden jerk caused by the upper coil slipping off the undermost.

It is to these causes that all the accidents that occur to workmen and machinery from the failure of chains may be attributed (bad iron excepted), and which form the sole objection to their becoming a general substitute for ropes.

As a preventive to these evils, I have grooves cast in iron pulleys, of sufficient dimensions to receive the lower circumferences of the links of the chain, which work vertically ; those which work horizontally and form the gudgeon part of the chain (if we may be allowed the expression), bearing upon each side of the grooves.

The barrels are also of cast iron, with spiral grooves of the same dimensions, at such distance from each other as to admit the chain to bed without the danger of a double coil ; by these means the links are retained at right angles with each other, the only position for free and uniform motion.

The links of the chains are made as short as possible, for the purpose of increasing their flexibility, and they are reefed perfectly free from twist, in the pulleys, and on the barrels, for the same reason.

When applied in blocks, the grooves in the pulleys prevent the different falls of the chain from coming in contact, and render plates between them (as in the common way) totally unnecessary ; the pulleys are in consequence brought closer together, the angle of the fall from block to block considerably diminished, and the friction against the plates entirely avoided. Brass guards, with grooves opposite to those in the pulleys, are riveted to the blocks, to prevent the chain getting out of its birth from any accidental circumstance. This method of working chains I first put in practice for Messrs. T. W. and B. Botfield, at these works, in July last ; and it is applied in the working of cranes capable of purchasing from ten to fifteen tons ; in the working of the governor balls of steam-engines constructed by Messrs. Boulton and

Watt,

Watt, and in the raising of coal and ore from the mines, for which purposes ropes had before been solely used at this manufactory. In all cases it has performed with the utmost safety, uniformity, and flexibility; so much so that the prejudices of our workmen against chains are entirely done away, and they hoist the heaviest articles with more ease, and as great confidence of safety as they would with the best ropes.

The same method is applicable, at a trifling expense, to all machines at present worked by ropes, or by chains, in the usual way: and all the common chains now in use may be applied to it with equal facility.

With a view of ascertaining the relative flexibility of ropes and chains, I wedged an iron pulley, thirty-one and a half inches in diameter, on the spindle of the pinion of a crane of the following description, viz.

Barrel, 30 inches diameter;

Wheel, 64 teeth;

Pinion, 8 ditto;

Top block, with three pulleys of 12 inches diameter;

Bottom block, with 2 ditto, ditto.

To the large pulley I attached a small rope, for the purpose of suspending the weights in the hoisting of the different loads, and the results were as follow:

The crane was loaded with	Took to hoist the loads when reefed with the chain in grooved pulleys*	Ditto, when reefed with a half-worn tarred strand-laid rope, $3\frac{1}{2}$ inches in circumference.	Ditto, when reefed with the chain promiscuously as in the common way
<i>lbs.</i> First . . 2000	<i>lbs.</i> 63	<i>lbs.</i> 74	<i>lbs.</i> 80
Second . 1000	32	39	41
Third . . . 500	17	21	22
Total . . 3500	112	134	143

* All the experiments were tried with the same grooved pulleys.

The

The flexibility is inversely as these momenta, and proves the superiority of chains ; for (on the average of the trials) with the chain in the grooves,

One pound raised - - - - 31·25 lbs.

With a half-worn strand-laid tarred rope,
three inches and a half in circumference - 26·11 do.

And with the chain in the usual way, only - 24·47 do.

It also appears (contrary to the general opinion), that chains are safer than ropes ; for it is an established axiom, that those bodies whose fibres are most in the direction of the strain, are the least liable to be pulled asunder ; and in our examination of the properties of a rope, we find that the strands cross the direction of the strain in undulated lines, and consequently prevent its uniform action thereon. A rope is subject to this inconvenience even when stretched in a direct line, but more particularly so when bent over a pulley, as in that position the upper section, moving through a greater space than the under one, is acted upon by the whole strain ; and hence the frequent breaking of ropes in bending over pulleys, from the double strain overloading the strands of which the upper section is formed.

The links of a chain are subject to the transverse strain, where they move in contact ; but as such strain is in proportion to the length of the bearing, it must be very trifling. All the links having axles of their own, the chain moves simultaneously with the strain, and both are in consequence retained in continual equilibrio. A chain in grooves will therefore sustain as great a weight when bent over a pulley, as it will in a direct line, and consequently is safer than a rope.

A safe, uniform, and flexible method of applying chains in the working of machinery has long been a desideratum in the arts ; for they are but little affected by exposure to the weather, or the heat of manufactories, whilst either produces the speedy destruction of ropes.

The discovery is of additional importance, as it substitutes a durable article for a very perishable one, and gives employment to our own manufactories at the expense of foreign im-
portations.

portations.—The durability is at least six to one in favour of chains.

Though the model of the crane is chiefly intended to convey a proper idea of the new method of working chains, yet I trust it will be found to possess several other advantages in point of construction, which are entirely new, and calculated to increase the safety and durability, as well as to lessen the expense of that useful machine.

On reviewing the principles of a crane, we find that the gudgeons are the points of resistance to the machine and its load, and consequently the effect of the transverse strain upon the perpendicular will be in proportion to the distance of the mortise for the gib from the upper one; and that of the oblique strain, in proportion to the distance of the mortise for the diagonal stay, from the lower one.

Notwithstanding these circumstances are so evident, they are seldom attended to; for in general a large and expensive piece of oak, sufficient of itself to make a crane of double the purchase, forms the perpendicular; the gib is mortised into it, at eighteen or twenty inches from the top, to make room for the gudgeon, as is the diagonal stay, at five or six feet from the bottom, to allow a birth below for the barrel. Thus the effect of the transverse and oblique strains of the gib and diagonal stay upon the perpendicular, is increased by their distances from the gudgeons, or points of resistance, and the perpendicular itself considerably weakened by mortises made where the greatest strength is required. Hence the frequent failure of cranes of the common construction, by the breaking of the perpendiculars in the mortises.

It appears, however, that the various parts of a crane formed of wood, cannot be connected together in any other way than by mortising; and as this method considerably diminishes the strength of the timber, I make use of cast-iron mortise pieces.

The perpendicular is formed of two oak planks, each eighteen inches wide, four thick, and sixteen feet long; these, at the top and bottom, are let into cast-iron mortise pieces, which retain the planks ten inches asunder. The
barrel

barrel for the chain, works between them. The piece at the top contains in the middle a dove-tailed mortise, into which a stock for the gib is fixed; for greater security, an iron bolt goes through the whole; the stock projects two feet from the mortise, and a plank eighteen inches deep, and four thick, is bolted to each side of it to form the gib, the interstice between the planks forming a birth for the top block to slide in. The diagonal stay is of the same dimensions, formed in a similar manner, and connected to the perpendicular, by being let into the lower mortise piece.

In this mode of construction scarcely any part of the timber is cut away; and the strength of the materials, so far from being diminished, is augmented by the cast-iron mortise pieces, the gib is brought much closer to the upper gudgeon, and the centre lines of the perpendicular and the diagonal stay crossing each other at the top of the lower one, places the whole strain as near as possible in a line with the gudgeons. The business of the perpendicular becomes in consequence little more than that of a mere prop, and consequently requires no greater strength of materials than the diagonal stay.

The top block is made of cast iron, and has a groove three inches deep on each side, for the purpose of embracing the planks which form the gib.

To prevent the inconvenience of the dirt of the floor getting into the brass of the lower gudgeon, and thereby obstructing the revolution of the crane, those parts are reverse to the common way, the gudgeon being fixed in the floor, and the socket part which embraces it is cast in the bottom of the mortise-piece, as is also a channel to convey oil to the gudgeon. I am, Sir,

Your most humble servant,

GILBERT GILPIN.

Old Park Iron-works, near Shifnal,
April 16th, 1804.

Reference to Mr. GILBERT GILPIN's Crane, Pl. VI.

Fig. 1, 2, 3, 4.

Fig. 1. represents the crane with all its parts complete, ready for work.

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AB,

A B, the perpendicular, formed of two oaken planks, each eighteen inches wide, four thick, and sixteen feet long, let into cast-iron mortise-pieces C D.

E E, the barrel for the chain which works between the two planks of the perpendicular.

F, the top piece, containing in the middle a dove-tailed mortise, into which H, a stock for the gib, is fixed ; an iron bolt goes through the whole, for greater security. The stock projects two feet from the mortise, and two planks I, K, eighteen inches deep, and four thick, are bolted one on each side of it, to form the gib, the interstices between these planks forming a birth or space for the top block L to slide in. This block is made of cast-iron, and has a groove three inches deep on each side.

M, the diagonal stay, is of the same dimensions as the gib, formed in a similar manner, and connected to the perpendicular by being let into the lower mortise-piece D.

N, the handle or winch which turns a small pinion O, fixed on the same axis ; this pinion works in the teeth of the wheel P, moving on the same axle as the barrel E, on which the chain R lies in spiral grooves.

S, the block and hook by which the goods are raised.

Fig. 2. is a side view of the handle N, the pinion O the toothed wheel, and the barrel E placed betwixt the two up-rights A B.

Fig. 3. shows upon an enlarged scale part of the barrel E, and some of the chain lying in its proper position in one of the spiral grooves, or channels : it is to be noted that the lower edge of one link lies in the groove, and the next link upon the surface of the barrel, and that by this means the chain is prevented from twisting in winding upon the barrel.

Fig. 4. shows a section of part of the barrel E, in order to point out clearly the manner in which one link lies within it, the other link on its outside ; it is contrasted by Fig. 7. the old method of working chains.

Certificates, dated November 22d, 1804, from Thomas Blackmore, John Swift, John Ball, Joseph Felton, Benjamin Heylehurst, Benjamin Hunt, and Thomas Hatchhess ; who declare that they were present at the trial of the experiments
above

above mentioned, that they had also seen the new method of working chains in daily use for upwards of sixteen months, and are certain, that in that way chains work much more flexible than hempen ropes, and equally as safe and uniform.

Further certificates from Messrs. I. W. and B. Botfield, lessees of Old Park iron-works, and Isaac Hawkins Browne, esq. landlord of the said works, confirm Mr. Gilpin's statement; and further add, that the method is calculated for chains of all sizes, and for machinery of every description; that it is employed at their works with great success, in the working of cranes and mill machinery, and in the raising of coal and ore from the mines. That his chains applied in this manner are a complete substitute for ropes, and will prevent those fatal accidents which too frequently occur to the workmen and machinery, in the working of chains in the usual way. That Mr. Gilpin's crane is also constructed upon stronger and more durable principles than those in general use, and completely answers its purpose.

XL. Description of Mr. PETER HERBERT's Improved Book-case Bolt *.

I HAVE taken the liberty of laying before the society a model of my invention, which I hope is sufficient to explain my intention. I intended it for a library book-case bolt, to facilitate the opening of both doors at once, and to secure the same, without the trouble of bolting two bolts in the common way. It will do for wardrobes, French casements, or folding sash doors. It will also make a good sash fastening, if let into the bottom sash, with a small brass knob to slide as common; it would bolt in the frame by the side of the sash cord, both sides at once. I can also make it to answer sundry other useful purposes if required.

I remain, Sir,

Your obedient humble servant,

PETER HERBERT.

No. 33, Bow-street, Covent-garden.

* From *Transactions of the Society of Arts, &c.* 1806.—Ten guineas were voted to Mr. Herbert for this invention, a model of which is preserved in the Society's Repository.