AN ALL-WROUGHT STEEL PULLEY.

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The different branches of the industrial world are so dependent on one another that progress in one line is invariably accompanied by, and keeps step with, progress in all the others. When an advance has been made in one branch, it will be found that the improvement is called for by some new demand in some branch which it serves, and has been made possible by an advance in another which has preceded it. Many lines of industry have found progress limited by the strength of the material used.

As the manufacturers of material improve their product, all the industries using that material are aided. This has been noticeable in gun and armor manufacture.

The recent advances in the manufacture of mild steel by the Bessemer and open-hearth processes have enabled those who use that material greatly to improve their product and to cheapen its cost. The benefit to the arts arising from this cause is most noticeable in the cases in which the steel-worker has been enabled to produce, on the practical commercial scale, articles formerly made of brittle cast iron. This has been realized in the case of many familiar articles of hardware and household use.

At present a mild grade of steel, of homogeneous structure, carefully rolled to thickness and in long sheets of convenient widths, can be bought at prices, pound for pound, below the cost of castings. In the hands of the skilled steel-worker this sheet can be formed into many articles of complicated structure without taking from its original strength.

Sprocket-chains and other parts of the bicycle, locks, hinges, shelf brackets, and many more simple articles are made cheaply of this strong, ductile material.

It is the purpose of the writer to describe in this communication, an ordinary belt-wheel made entirely of such steel, and representing the highest development of the sheet metal worker's art up to the present day.

Figs. 1 and 2 will give a general idea of the design. The rim is built of four segments. It is divided once transversely and once longitudinally. A means of attachment to the arms is given by the deep flanges which are turned in at the center of the face. The rim edges are stiffened by being turned into a curl, which gives an attractive appearance and avoids scaring the belt in throwing on or off.

The hub is composed of two half cylinders of heavy metal. The hub and rim are connected by four spider pieces—two in each half pulley. As will be seen in *Fig. 2*, there is a spider piece starting at each end of the hub, and which embraces and is fastened to the hub-shell. As the spider arms branch toward the rim, the two opposite arms approach each other, forming a pyramid, and at the

ends they are riveted to the deep flange in the center of the rim.

The arms being of a flat piece, with its edges lying in the direction of rotation, and the two opposite arms being dished towards each other, makes the structure well suited to resist the strains to which it is to be subjected. The lateral stiffness is greatly increased by the deep corrugations which run the length of the arms.

Figs. 3, 4 and 5 will show clearly the method of making one of the spider sections. A flat piece like *Fig. 3*, called

the hand, is slit as there shown, giving three fingers and a palm. The palm and fingers are then bent at right angles, as in *Fig. 4*.

In another operation the palm is given a convex shape and the fingers take the shape of radial arms, *Fig. 5*.

The ends of the hub are embraced by hub clamps which are attached to each half pulley. The pulley is clamped to the shaft by means of four bolts.

The company building this pulley has taken a step in line with others in advanced practice, by advocating their use in the heaviest service without keys.

The steel hub shell on a steel shaft has a very high coefficient of friction. The clamps are designed so that they make the shell hug the shaft closely all around, and with four bolts there is no danger of slipping. Pulleys thus clamped have driven power-presses, with the severe shock and jar to which they are subjected, without any sign of slipping.

No machine shop operations are needed on this pulley. By carefully designed dies and shears each part is made to exact size. The rim and arms are pressed to their final shapes by heavy and specially designed hydraulic machines.

One of the features of interest in the manufacture of this apparatus is the economy of material. The actual gross weight of the stock, bolts and rivets used in a pulley of 24 inches diameter by 6 inches face is 26 pounds 5 ounces. The finished pulley weighs just 24 pounds. The total waste in punchings and shearings is, therefore, only 2 pounds 5 ounces, and this scrap is salable at a rate which materially reduces the loss. The waste in turnings, borings and gates on a cast pulley of this size would be about 15 pounds with a finished weight of 75 pounds. Furthermore, being entirely symmetrical in construction, the pulley, as made, is in perfect running balance without the necessity of adding counter-balance weights.

In designing the ideal wheel to be used under the ideal conditions, the engineer would find three strains to be resisted. In the case of a 24-inch pulley with a 6-inch face, there would probably be in running conditions 450 pounds on the tight side and 150 pounds on the slack side of the belt. This would give a force of 600 pounds, tending to crush the rim and compress the arms. The rim overhang-

ing on each side of the arms, the action of the belt would be to cause buckling of the edges. Then the difference between the tension on the tight and slack sides of the belt, which is equal to 300 pounds, is the effective work of the belt and gives a bending strain to the arms. These calculated strains are all trifling, but frequently, by accident or by quick variations in speed of driving or driven pulley, there are strains ten times as great as those exerted by the belt.

In designing a structure subject to so great variations of stress, the engineer would choose a material which combines strength and toughness, rather than the brittle cast iron.

The weakness of cast iron, when used as the material of pulleys, has been accentuated by casting the rim, arms and hub in one piece. The uniting in one casting of heavy and light sections, and of such as lie at right angles to one another, is as great a mistake, in the moulder's art as were the Siamese twins in the living world.

Instead of pulling together, these three parts pull against one another, and often resist even to open rupture.

The foundryman guards against this happening in his hands by making the casting much too heavy.

The cast-iron pulley to-day has reached its full development. It is true and graceful, is given tolerable balance by adding weights to the light side, and is made to fit exactly one standard size of shaft; but in spite of all these good qualities, worked out by the best engineering skill, it is defective because of the prime mistake in the first operation of making them. The wood pulley, being light, interchangeable as to bore, and cheap, has been sold largely of late years. It is not durable, however, and increases the fire risk where it is carried in stock by dealers. It has been left to Yankee genius and Philadelphia capital to produce a pulley which, being made of the very best and strongest material, corrects the mistake in the standard wheel.

Gears, cranks and levers are each used on many machines, but pulleys are used more than any other mechanical device. There is no factory that does not use them in

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quantities. In the present state of the mechanical world they are as universal as machinery itself. Now, a mechanical method which, on a device in such general use, at once reduces the amount of material used to one-third the former practice, reducing also to the same extent the weight and corresponding inertia and frictional resistance to shafting rotation, should be worthy of the attention of the mechanical world. This is accomplished without any expensive operations, and by methods essentially American in their origin, and by which Americans have made not only such simple articles as hardware fixtures, but also such refined ones as watches.

The pulley here described is the invention of Mr. Thomas Corscaden, who has long been engaged in making specialties in steel, some of which are familiar articles to the public to-day. He conceived the idea of making this pulley as far back as 1888. Dull times giving leisure and stimulus to take up something new, drawings and models were made and experimented with. In 1892 patents were taken out on the pulley and on the machinery for making it. With the co-operation of Mr. George V. Cresson, a member of this Institute, and an extensive manufacturer of power-transmitting machinery, the American Pulley Company was formed, and a factory was equipped in Philadelphia for the purpose of manufacturing the pulley under Mr. Corscaden's patents. Under his superintendence special machinery, dies and tools were designed and built, which permit of the production of several hundred pulleys daily.

The pulley has attracted the attention of the engineering public, both at home and abroad, and its extensive adoption already appears to be well assured.

IN MEMORIAM.

ROBERT WRIGHT.

Robert Wright, son of Jonathan and Mary Wright, was born February 19, 1817, at Keighley, Yorkshire, England, and died January 11, 1897, after having lived a life of great usefulness, characterized by a modesty as conspicuous as