MR. BRUSH'S WINDMILL DYNAMO.

It is difficult to estimate the effect of an invention on existing practices and industries. Occasionally a new invention will appear which will greatly affect a whole range of allied inventions and industries in such a way as to entirely change time-honored customs, inaugurate new practices and establish new arts. The commercial development of electricity is a notable example of this.

After Mr. Brush successfully accomplished practical electric illumination by means of arc lights, incandescent lighting was quickly brought forward and rapidly perfected. Gas lighting was also improved in various ways. Simultaneously with these, the electric distribution of power was carried forward, and important improvements were made in prime movers for driving dynamos. In this direction much has been done both in steam and water motors. Wind power has been repeatedly suggested for driving dynamos, but the adaptation of the windmill to this use seems to have been a problem fraught with difficulties. Few have dared to grapple with it, for the question not only involved the motive power itself and the dynamo, but also the means of transmitting the power of the wheel to the dynamo, and apparatus for regulating, storing and utilizing the current.

With the exception of the gigantic windmill and electric plant shown in our engraving, we do not know of a successful system of electric lighting operated by means of wind power.

The mill here shown, as well as all of the electrical apparatus used in connection with it, and the very complete system by which the results are secured, have been designed and carried out according to the plans of Mr. Charles F. Brush, of Cleveland, Ohio, and under his own personal supervision. As an example of thoroughgoing engineering work it cannot be excelled.

Every contingency is provided for, and the apparatus, from the huge wheel down to the current regulator, is entirely automatic.

The reader must not suppose that electric lighting by means of power supplied in this way is cheap because the wind costs nothing. On the contrary, the cost of the plant is so great as to more than offset the cheapness of the motive power. However, there is a great satisfaction in making use of one of nature's most unruly motive agents.

Passing along Euclid Avenue in the beautiful city of Cleveland, one will notice the magnificent residence of Mr. Brush, behind which and some distance down the park may be seen, mounted high on a tower, the immense wheel which drives the electric plant to which we have referred. The tower is rectangular in form and about 60 feet high. It is mounted on a wrought iron gudgeon 14 inches in diameter and which extends 8 feet into the solid masonry below the ground level. The gudgeon projects 12 feet above the ground and enters boxes in the iron frame of the tower, the weight of the tower, which is 80,000 pounds, being borne by a step resting on the top of the gudgeon. The step is secured to a heavy spider fastened to the lower part of the frame of the tower.

In the upper part of the tower is journaled the main wheel shaft. This shaft is 20 feet long and 6½ inches in diameter. It is provided with self-oiling boxes 26 inches long, and carries the main pulley, which has a diameter of 8 feet and a face of 32 inches. The wheel, which is 56 feet in diameter, is secured to the shaft and is provided with 144 blades, which are twisted like those of screw propellers. The sail surface of the wheel is about 1,800 square feet, the length of the tail which turns the wheel toward the wind is 60 feet, and its width is 20 feet. The mill is made automatic by an auxiliary vane extending from one side, and serving to turn the wheel edgewise to the wind during a heavy gale. The tail may be folded against the tower parallel with the wheel, so as to present the edge of the wheel to the wind when the machinery is not in use. The countershaft arranged below the wheel shaft is 3½ inches in diameter, it carries a pulley 16 inches in diameter, with a face of 32 inches, which receives the main belt from the 8 foot pulley on the wheel shaft. This is a double belt 32 inches wide. The countershaft is provided with two driving pulleys each 6 feet in diameter, with a face of 6½ inches, and the dynamo is furnished on opposite ends of the armature shaft with pulleys which receive belts from the drive wheels on the countershaft.

The dynamo, which is one of Mr. Brush's own design, is mounted on a vertically sliding support and partially counterbalanced by a weighted lever. It will be seen that the countershaft is suspended from the main shaft by the main belt, and the dynamo is partly suspended from the countershaft by the driving belts. In this way the proper tension of the belts is always secured, the total load on the dynamo belts being 1,200 pounds, and on the main belt 4,200 pounds. The ends of the countershaft are journaled in sliding boxes connected by equalizing levers which cause both ends of the shaft to move alike. The pulleys are so proportioned that the dynamo makes fifty revolutions to one of the wheel. The speed of the dynamo at full load is 500 revolutions per minute, and its normal capacity at full load is 12,000 watts.

The automatic switching devices are arranged so that the dynamo goes into effective action at 330 revolutions a minute, and an automatic regulator is provided which does not permit the electromotive force to run above 90 volts at any speed. The working circuit is arranged to automatically close at 75 volts and open at 70 volts. The brushes on the dynamo are rocked automatically as the load changes. The field of the dynamo is slightly compounded. The current passes from the dynamo to contact shoes of polished and hardened steel carried by a cross bar on the tower, which shoes slide on annular plates surrounding the gudgeon. Conductors extend underground from these plates to the dwelling house. To guard against extraordinary wind pressure, the tower is provided at each of its corners with an arm projecting downwardly and outwardly, and carrying a caster wheel very near but not in contact with the circular rail concentric with the gudgeon. Ordinarily, these caster wheels do not touch the rail, but when the wind is very high, they come into contact with the rail and relieve the gudgeon from further strain.

In the basement of Mr. Brush's house there are 408 secondary battery cells arranged in twelve batteries of 34 cells each; these 12 batteries are charged and discharged in parallel; each cell has a capacity of 100 ampere hours. The jars which contain the elements of the battery are of glass, and each cell has its liquid covered with a layer of "mineral seal" oil, a quarter of an inch thick, which entirely prevents evaporation and spraying, and suppresses all odor. The automatic regulating devices are shown in one of the views of our engraving. At 1 are shown the voltmeters and ammeters employed in measuring the charging and discharging currents; at 2 is shown a series of indicators, one for each battery; 3 represents an electrically operated switch by means of which the current may be turned on or off the house mains by pressing push buttons in different portions of the house; 4 represents a ground detector, which is connected with the center of the battery and with the ground, so that should the conductor upon either end of the battery be grounded, the fact will be indicated by the movement of the index in one direction or the other from the zero point of the scale, thus showing not only that the battery is grounded, but indicating the grounded pole; 5 is a leakage detector connected up with the lamp circuits, and arranged to show any leakage from one conductor to the other; at 6 is shown a compound relay for operating the automatic resistance shown at 7. This resistance is placed between the batteries and the house mains, and is arranged to keep the voltage on the lamps constant at all times. In this device the resistance is secured by means of powdered carbon placed under varying pressure, the necessary movement being made by means of hydraulic pressure under the control of the relays.

The house is furnished with 350 incandescent lights, varying from 10 to 50 candle power each. The lamps most commonly used are from 16 to 20 candle power; about 100 incandescent lights are in every day use. In addition to these lights there are two arc lights and three electric motors. It is found after continued use of this electric plant that the amount of attention required to keep it in working condition is practically nothing. It has been in constant operation more than two years, and has proved in every respect a complete success.

The Faithful Dog of Helvellyn.

A monument has just been erected on Helvellyn (a mountain of Cumberland, England, 3,300 feet high) to the memory of Charles Gough, who, in the year 1805, was killed by falling from the high crags on the ridge that joins Striding Edge to the summit; and of the faithful dog who for three months watched over her master's remains. Sir Walter Scott describes the event in the poem "I climbed the dark brow of the mighty Helvellyn," and Wordsworth records it in his lines on "Fidelity."

The young man was returning to Wythburn, where he lodged, from a fishing excursion in Patterdale. The accident was probably caused by a false step, during a blinding hailstorm or a dense fog that day. It happened on April 18, and on July 20 his bones were found, still watched by the starving dog, a little yellow, rough-haired female terrier. She had given birth to puppies, which were found dead by the side of the corpse. It is believed, though unable to secure enough food for milk for her young, she maintained life by bits of carrion sheep which are not unfrequently found on the hills; but she might have had to range far and wide during her three months' watch. The mere fact that the bones were found intact serves to prove the assertion that the dog did not touch the remains of her master, for dogs break the bones to suck the marrow. This animal died a few years afterward at Kendal.

The merit of the suggestion to erect this monument belongs to Miss Frances Power Cobbe, whose design has been carried into execution by the aid of the Rev. H. D. Rawnsley, Vicar of Crosthwaite, both names of some repute in literature.—*Illustrated London News.*

Correspondence.

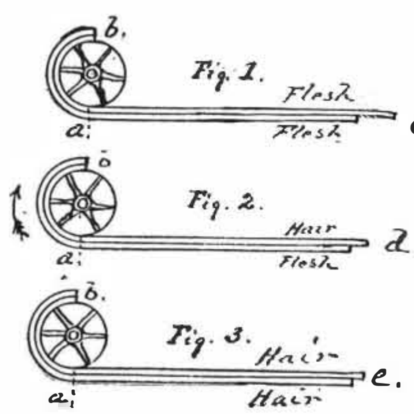
THE BELT PROBLEM.

To the Editor of the Scientific American:

We notice the "belt problem" did not escape attention. It is a little strange, however, that a "head engineer" should miss the mark so widely in attempting to explain the reasons for the *creeping* of a belt.

At first thought, there seems to be little or no importance attaching to this question, but by following it up, facts may be revealed that are of use, both in making and using leather belts. The side of a belt which should be run next the pulley, we think, has not been fully settled, though double belts, we believe, are made with the flesh sides together. So it makes no difference which side of such a belt is used next the pulley, unless it be on account of riveting.

The effect of placing leather together in different positions may be seen by a very simple experiment, as shown in Figs. 1, 2 and 3. Take two strips of leather



of equal length, place the two finished or hair sides together and the ends at *d*, Fig. 1. Hold the other end at *c*, with equal tension, turn the pulley in the direction of arrow, and stop at *b*. If the pulley be 6 in. diameter, the ends at *c* will be found to be 1¼ in. apart. The same experiment is shown at Fig. 2, except that one hair and one flesh side are placed together, with hair side next the pulley. We now find a difference of 1 in. at *d*. The result is the same if the flesh side is next pulley and the hair side out. By placing both flesh sides together, as shown in Fig. 3, we find the slip at *e* to be ¾ in., only one-third as much as at *c*, Fig. 1.

We conclude from this that the flesh side of the leather is the more rigid, whereas this side is usually taken for the soft and flexible side. The test in Fig. 1 shows that the hair side of the under belt has expanded, and the same side of the other belt has contracted as much as was necessary to allow for the difference in diameters between the pulley and the outside of outer belt, the fibers on flesh side retaining their normal condition. In Fig. 2, the hair side next the pulley has contracted, so it has taken more belt to reach around the pulley; hence the difference of ¼ in. between *c* and *d*. In the case of Fig. 3, the hair side on inside has contracted, and that on outside stretched, but not enough to make up the entire difference in diameters of these surfaces. Had they done so, the end at *e* would be even and show no creeping. This shows some flexibility in the flesh surfaces, but not one-third as much as in the hair sides. That on the flesh side, however, is much more evenly distributed than on the hair side, as will be seen by bending the leather first one way and then the other. Under such action the flesh side remains smooth while the other crumples and presents a very uneven surface. This of itself, we think, is a strong reason for working the flesh side of a belt next the pulley; and for a double belt, the form in Fig. 2 would, therefore, be best, with the belt reversed. As long as a belt continues to stretch, its limit of elasticity must evidently be exceeded by the working strain, and with double belts this strain is greatly increased by the stretch or tendency to creep, while passing around the pulleys, and especially when the latter are comparatively small. Were it not for the rough surface presented to the pulleys by the hair side, we would favor the form of double belt shown in Fig. 3, for in this there is less tendency to creep than in any other. It would seem desirable to fasten leather together the way in which it is most natural for it to remain.

We have dealt with this subject more at length than we expected in the beginning, but as leather belts are not likely to be wholly superseded by other means of transmission, some of your many readers may take an interest in the subject. QUIRK.

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