of wonder than the presence of these monuments at a point which evidently is far away from the quarries whence the monoliths were taken. The statues are made without pedestals, and are disposed in groups of four each. First come four lions, then four rams, then camels, elephants, horses, and finally chimeras. In each group two animals are represented standing and the other two lying down. After the animals follow the statues of four military mandarins, four civilian mandarins, and four of China's celebrated men.

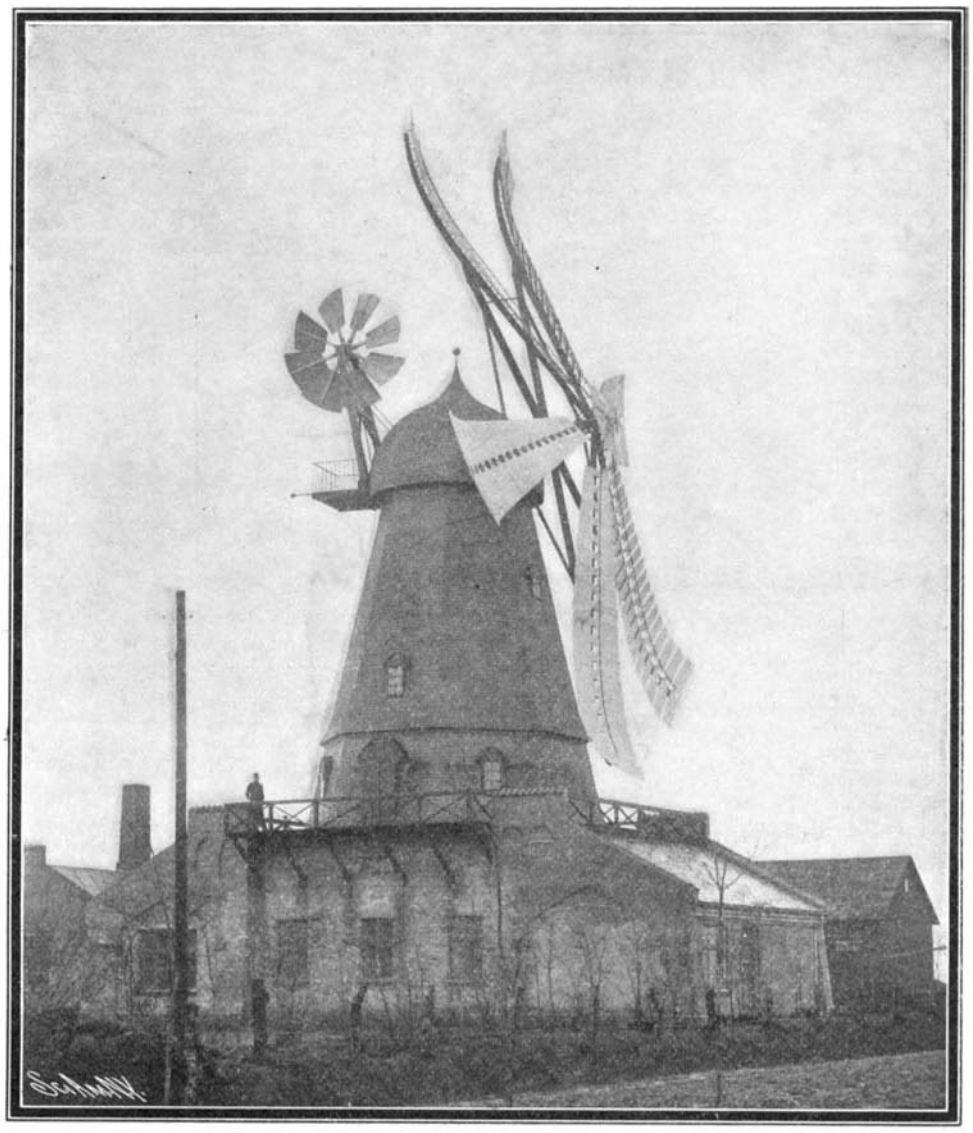
Thirteen hills surround the burying grounds, and from each of them a good general view may be obtained. The impression created by this strange sight is quite peculiar. The statues of the animals, rising immediately from the ground without pedestals, and surrounded by the high grass, have a degree of realism which is entirely lacking in Occidental statuary, with its elaborate pedestals and inclosures. The Japanese authorities issued instructions that the tombs and statues be respected. It is to be hoped that no stray shots in the recent battle may have struck these curious statues.

POWERFUL GERMAN WINDMILLS.

BY CHARLES B. HAYWARD.

In this country, while the windmill is in universal use, its scope of duty seems to be confined almost entirely to the driving of pumps or other water-raising appliances, though experiments have been made to adapt it to the production of electrical energy with the aid of accumulators to tide over periods of calm. However, it is not evident that this was ever carried beyond the experimental stage or that the windmill at its best in this country is much more than a sort of "farmer's assistant," acting in the capacity of a drawer of water.

In Germany this most economical of all powers has been developed to a point that is surprising. The Empire has not the abundant supply of water power with which this country is blessed, nor is cheap fuel present in such quantities. Even the "spiritus" or raw potato alcohol, of which millions of gallons are now annually consumed in hydro-carbon engines, is not as economical a source of power as the wind, though it sells so low as to be the strongest competitor of American petroleum in the German market. Accordingly, a great deal more attention has been paid to the development of means for taking advantage of wind-power than here. This is manifest in the number and variety of articles and books on the subject in German which deal with the windmill as a source of power for general purposes, whereas about the only information of the kind obtainable in this country deals with it in connection with irrigation and is contained in bulletins issued by the Department of Agriculture. Naturally not every locality is suited to the use of a windmill, but a great many parts of Germany have been found to be favorably adapted to its use, both on the coast and in the interior.

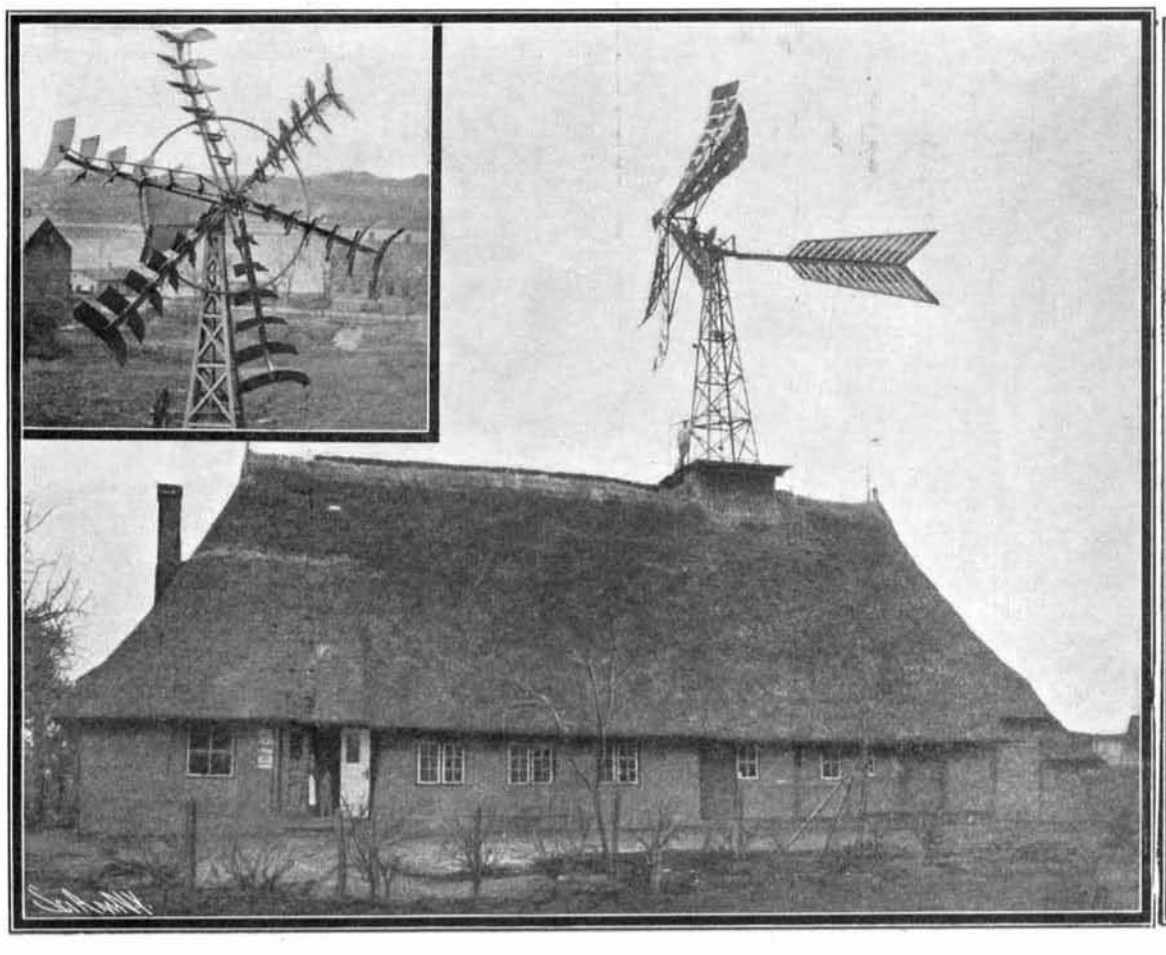


A 50-Horse-Power Wheel. One of the Most Powerful Windmills in Existence. Built for Electric Lighting and General Power Service.

The oldest forms of wind motors are the German or trestle windmill, and the Holland or tower mill, and many of these of both types are still found throughout Holland and North and Central Germany. The Holland form, however, owing to its solidity and general good service, has in large measure displaced the trestle mill. From the modern standpoint both these are very antiquated, as it is now more than a century ago that Americans began to improve upon these types, and the result is the windwheel of to-day. Fixed framing was primarily employed, but later gave way to an adjustable frame, this latter being closely associated with the so-called wind turbines.

The oldest types of these windwheels were those of Allen, Halladay and the Eclipse, while an early type of the present wind turbine was introduced by Leffel. Then there was the Wolff turbine, constructed with a horizontal wheel similar in principle and position to the axial water turbine. But this idea apparently did not meet with success, for the present type has a vertical vane carrier, the guides of which are of arched or scoop form. The horizontal wheel referred to was not the first of its kind by any means, as a patent was granted in England to Robert Beatson, F.R.S.E., for a horizontal windwheel prior to 1798. This, however, was based on an entirely different principle. Like many another inventor, Beatson was confident that his invention was destined to revolutionize windmill construction, and in an essay exploiting it he refers to the fact that horizontal windwheels of the same basic principle were largely used at the time in parts of Tartary and Asia as well as some provinces of Spain. Square sails similar to those of a sailing ship were used, but the great difficulty was that the resistance of the returning vane almost cut in half the power of the active side. In the countries in question this was overcome by screening the idle side from the wind entirely. But one-half of the wheel was thus exposed at any time, and as the screen was not an automatic device it was impractical, owing to the necessity of attendance, to shift it with changes of the wind.

Smeaton disagreed with Beatson on every point and averred that a horizontal wheel could not be constructed that would have the efficiency of the common or vertical type. Beatson's wheel consisted of four upright frames placed at right angles to one another on the arms of a spindle, each frame being filled with a large number of light wood slats or canvas flaps,



A 6-Horse-Power Wheel for Farm Work.

An 18-Horse-Power Wheel, 40 Feet in Diameter.

POWERFUL GERMAN WINDMILLS.

slightly overlapping each other and so hinged or hung on gudgeons as to hold the wind from one side and fly open when blown upon from the other. Thus the resistance of the idle vane to the wind was but a very small fraction of the power developed, as only the edges of the slats were presented. A model of his wheel was erected on the roof of his residence at 15 Great Windmill Street, London, and he figured that with four vanes each twelve feet square it would be capable of developing nine horse-power. He also prepared a table of wind velocity and resistances.

American wheels were largely introduced throughout Germany as a result of the Centennial Exhibition of 1876, and quite a business was done in this class of machinery until the German manufacturer realized that he could build the same thing to greater advantage, and there are at present upward of half a dozen large concerns in the Empire devoted to the construction of windwheels, each operating under a system and patents of its own. The portable windwheel and pump seem to be a feature of this class of power peculiar to Germany, and are used for irrigating, draining, and general agricultural purposes.

Numerous of the smaller towns throughout Germany utilize wind power almost exclusively for their municipal waterworks and in a few instances for public lighting, both of these applications having proved an unqualified success. Needless to add, the utilization of wind power on such an ambitious scale is practically unthought of here. The town of Emden is a good instance of the former, an 18-horse-power, 40-foot wheel being used at its pumping station at Tergast. It is of the slat-vane type familiar in this country, but in place of the usual rudder is equipped with two auxiliary windwheels, as is the case with all high-powered German wheels. These wheels are set at right angles to the main wheel on the end of a bridge-like construction, and are connected to the tower by means of shafts and gearing. Their motion causes the whole upper work to revolve about the tower, thus always maintaining the wheel face to the wind. This feature is a radical departure from American practice which immediately strikes the reader, and may be accounted for by the fact that such powerful wheels have never been employed here in any capacity. The wheel under consideration is coupled to a compound vertical pump having a capacity of 5,500 to 6,600 gallons per hour, according to speed. Its remarkable efficiency is evidenced by the fact that it delivers the water at this rate to a reservoir eight miles distant and 134 feet high. Two 10-horse-power petroleum motors are used as a reserve.

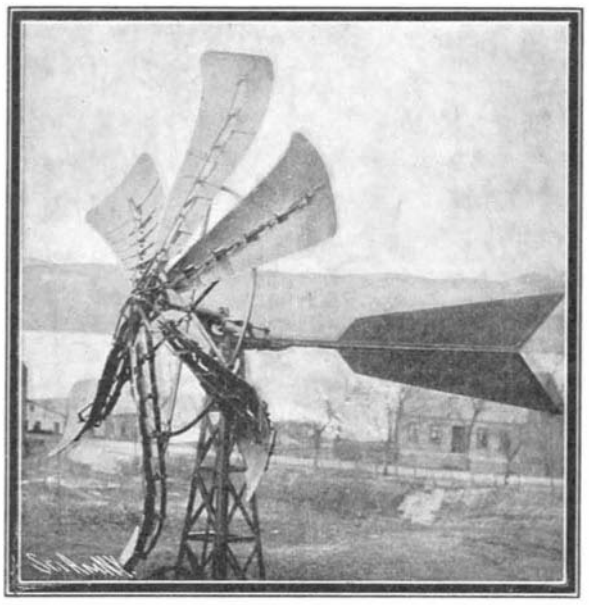
One of the principal German builders, located at Kiel, has for some years past been developing the "Soerensen" system, for which patents have been granted to a Dane of that name. Apparently the principle that has been proceeded on ever since windwheels have been in use is "the larger the surface, the greater the power," but the investigations of Prof. P. La Cour proved the fallacy of this reasoning. Later on Soerensen invented his "conical wind motor" and placed one at the disposal of Prof. La Cour for experimental purposes. The "Ventrokat" and "Windrose," types of German wheels of the highest efficiency, were tested together with a Soerensen wheel, all being of the same diameter, and showed the following results:

	Ventrokat	Windrose	Soerensen
Surface in centimeters.	7,440	2,976	1,188
Power in kilogramme-seconds	1.59	1.77	2.34

Thus the Soerensen motor developed 50 per cent more power than the Ventrokat with a surface of one-seventh the area, and 33 1-3 per cent more than the Windrose with its 2.8 times greater area, and 29 per cent more power than an earlier type of Soerensen motor which had but 7 per cent less surface.

The extraordinary superiority of this motor over existing types is due in great part to the form of its vanes, particularly at their ends, where the greatest wind pressure is exerted, but the unusual distance between the vanes adds an element of power, the importance of which has hitherto been totally overlooked. This space not only permits of the passage of the wind between the arms so that the latter meet with greatly decreased resistance in revolving, but a vacuum is seemingly created, and this with the absence of back pressure accelerates the motion of the wheel.

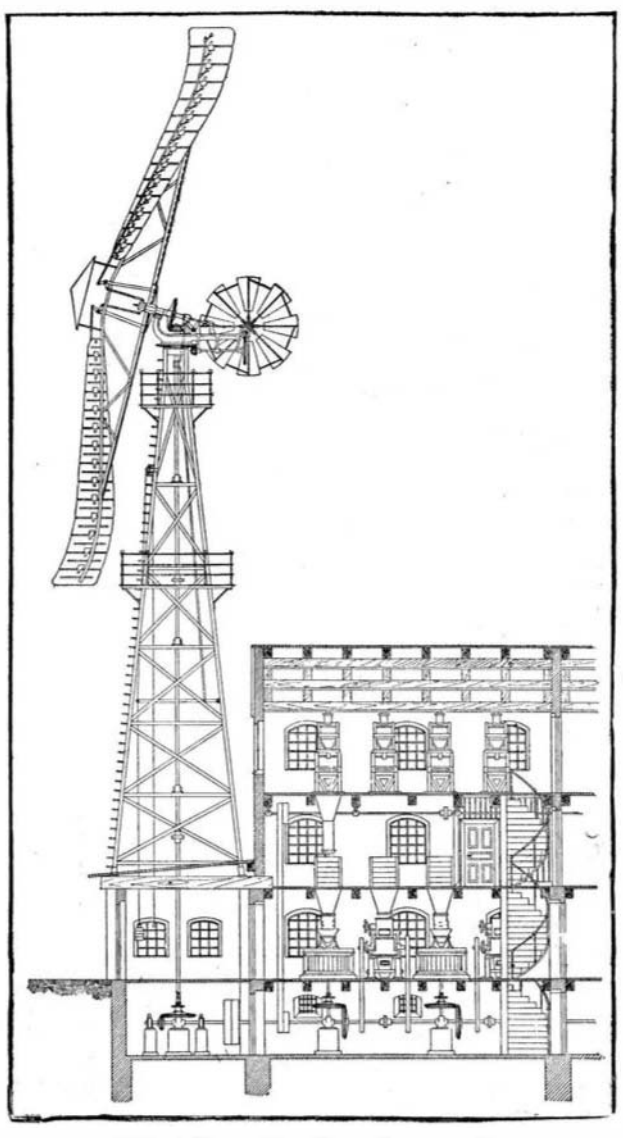
Some of the illustrations show a 6-horse-power wheel for pumping, mounted on a barn roof, and a 9½ and a 15 horse-power wheel respectively, the latter supplying power for quite extensive milling plants. The huge tower wheel shown was designed and built especially for electric lighting. With the wind at 7 meters (or approximately 23 feet) per second it develops 50 horse-power and is without doubt the largest wheel ever built for any purpose. Naturally the most difficult problem to be overcome in adapting the windwheel to electric lighting is the matter of speed regulation, but this has been very successfully solved by means of various regulators, prominent among these being the Rontescher "Tourenregler." By reason of the high first cost and expense of maintenance of a battery of accumulators of sufficient capacity to relieve the generator of the above wheel during periods of calm, it has been found much more economical to install gasoline engines as a reserve. How infrequently the latter are needed is evident from the fact that during the



A 4-Horse-Power Wheel for General Farm Work.

two or more years this set has been in use, there have scarcely been thirty days per annum in which the wind failed.

In this connection it is interesting to note that a plant of the above type using gasoline power as a substitute and representing a total investment of 18,000 marks has earned a net dividend of 12 per cent on the capital, while the same plant with gasoline power alone installed at a cost of 11,000 marks falls far below this. As already referred to, a public electric lighting service depending upon wind power is successfully maintained in a Danish village, so there is no reason why isolated farms cannot accomplish all the power work necessary by means of electric current generated by a windwheel. For periods of calm horses may be substituted. It is further the practice to equip such plants with two dynamos, one much smaller to be used



Section Through a Wind-Power Plant.

GERMAN WINDMILL PRACTICE.

with a moderate wind, both being run in very heavy winds.

A 15 horse-power wheel of the Soerensen conical type is employed to run the machine shop at a small government dockyard in the town of Husum, Germany, and is very efficient. With a wind speed of exactly 4.4 meters, or 6.7 miles per hour, this wheel has driven a 12-foot engine lathe, a shaper, a blower for two forges, and a circular saw of 20 inches diameter, sawing a 7-inch oak log, all the machines being driven at the same time and at full speed.

MULTI-FIREARMS OF ANCIENT TIMES.

A very rare and curious specimen of an ancient repeating flint-lock pistol has lately come into the possession of Mr. Sumner Healey, of this city. The pistol, of which we produce a drawing and photograph, was made at the end of the seventeenth century by Wetschgi Augustus, who died in Vienna A. D. 1690. The pistol contains two magazines, one, *A*, which contains the powder, and the other, B, contains the balls, twenty-one in all. An additional priming magazine *H* is on the outside of the lock and close to the flash pan. To load, one depresses the muzzle and turns or rotates the cylinder *C* by means of its exterior lever. One of the balls contained in the magazine *B* drops into the cavity *E*, which comes opposite *B*. At the same time the powder chamber *D* of the cylinder is filled with powder from the magazine *A*. When continuing to rotate the cylinders, the ball contained in the cavity *E* falls into the funnel-shaped breech, and by a continued motion of the cylinder the cavity *D* is brought opposite the breech of the barrel, where it remains until the shot is fired. During this time the reduced prolongation of the cylinder at the exterior rotates and scoops from the magazine *H* a sufficient quantity of powder to prime the flash pan. A continued movement closes the flash pan cover *G* and brings the hammer to full cock. When the pistol is fired, the priming charge shown at *E* communicates the fire through the two small holes to the charge contained in the cylinder.

The weapon bears the following inscription: FECIT ET INVENTIT WETSCHGI AUGUSTAE.

It may be readily seen that unless the revolving cylinder is accurately fitted, the danger of using such a weapon must be great, the powder in the butt, sufficient for twenty-one charges, being separated from the barrel only by the revolving cylinder, which serves as a false breech for the barrel.

A weapon of like construction to the above is in the Musee d'Artillerie, Paris, and is catalogued as M1766, but very few of these weapons, either gun or pistol, are known to be in existence. Among others who built similar weapons are Jan Sander, of Hannover, and Antonio Constantin, of Ferrara, Italy.

From a military point of view, the design of the arm gives evidence of being far in advance of its time. If everything works properly, the arm can be fired nearly as quickly as a modern weapon of to-day. Very little time is required for charging, and it is only necessary to fill the compartments with bullets and powder through the orifice *F*, with no counting and measuring. The charges are automatically measured, and the load is fully as accurate as that of metallic cartridges.

Altogether, the design and workmanship of the pistol make it a most valuable and remarkable relic.

Another pistol in the same gentleman's collection is a four-shot flint-lock pistol (Fig. 7). The weapon is evidently of English origin, and was presumably manufactured about 1750. It has two separate hammers, two triggers, and two separate flash-pan covers. The two upper barrels are fired separately by pulling the respective triggers. When these are fired, to fire the lower barrels one turns the lever shown at the center of the pistol, which brings two fresh primings in contact with the sparks from the flints, and thus communicates the flame to the two lower barrels through an orifice which is opened by the turning of the lever.

The arm can be fired quickly. All that is necessary after the first two shots are fired is to reclose the flash pan covers and to recock the hammers.

Fig. 8 shows a two-barrel, English flint-lock pistol with spring bayonet attachment, made by Nock, the celebrated London gunsmith. The pistol works on the principle of that shown in Fig. 7, with the exception that it has two barrels and one hammer and flash-pan cover only.

Fig. 9 shows a United States flint-lock pistol, caliber 70, made for the United States government by Simeon North, Berlin, Conn., about 1813. No pistol made for the government in early days is so much sought for by collectors as this, known as "North's Berlin." On the lock plate, in the rear of the hammer is stamped "S. North, Berlin, Con." Between the hammer and the pan is an eagle and under the eagle is stamped "U. States."

This particular model was only made one year, and but very few are known to be in existence.

Fig. 6 shows a two-barrel, revolving flint-lock pistol made by Bauduin, a French gunsmith, about the middle of the eighteenth century. This arm may readily be called the precursor of the modern revolver. The top barrel being fired, one revolves the barrels by hand, and as soon as the hammer is recocked, the pistol is ready for the second shot.

Among some guns in the same gentleman's collection, photographs of a few of which we reproduce, is that