THE WINDS OF THE UNITED STATES AND THEIR ECONOMIC USES.

By P. C. Day,
Climatologist and Chief of Division, United States Weather Bureau.

SOURCE OF DATA.

At each of the principal telegraphic reporting stations of the Weather Bureau in the United States there is maintained, by use of the most approved apparatus, a continuous record of the velocity and direction of the wind. These records at many of the stations extend back to the establishment of the Government weather-reporting service in 1871, thus furnishing continuous records of wind velocity for the past 40 years.

The total number of stations at which a continuous record of wind movement is now maintained by the Weather Bureau is about 200, which, with others that have been in operation during portions of the above period, but discontinued for various reasons, makes it possible to obtain fairly good records of the hourly, daily, monthly, or annual values of the wind movement at about 300 different points well distributed over the United States, and embracing every character of exposure from near the level of the sea to the tops of some of the highest mountains.

Probably in no other country of the world has there been accumulated such a wealth of data from which to deduce important information as to the character of the winds, their peculiar distribution, and their variations over such a large area as is now available from the records of the U. S. Weather Bureau.

Despite the fact that many of the data so collected have been printed both monthly and yearly in the various Weather Bureau publications, no extensive compilation of these individual values into harmonious totals, averages, etc., has been published in convenient form for ready reference by those interested in the study of the winds, either in scientific investigations or in the practical application of their energy to usefully serve our every-day needs.

DISCUSSION OF AVAILABLE DATA.

In any discussion of the winds, their force, or direction, it is of first importance that the elevation of the registering instrument above the ground during the period of observation be known, as also the details of the local environments.

On account of the commercial demands for prompt information regarding weather conditions, it is generally necessary to locate Weather Bureau offices, including the instrumental equipment, at points in close contact with the great business centers, often in the very heart of the larger cities, where the erection of new and taller buildings in the immediate vicinity, which interfere with the proper exposure, requires frequent changes in the elevation of the instruments.

As a result of these changes in elevation and environment, the compilation of average values of the wind movement or direction is attended with much difficulty when attempt is made to reduce the observed data to some standard elevation and exposure for all stations.

The accompanying charts (Pls. XXIII to XXIX), showing the average hourly velocities of the wind and its direction throughout the various portions of the country and for special months of the year and hours of the day, with diagrams indicating the daily march of the winds and their variations at different levels, present a graphic summary of some of the more important features of a paper on the winds of the United States which the writer is now preparing for publication as one of the series of bulletins issued by the Weather Bureau.

The limits of this article will not admit of the publication of detailed tables or of any extended discussion of the local features that a close study of the individual tables may disclose, and only a few of the more important details will therefore be touched upon in this brief review.

The data from which the charts were prepared are based mainly upon records for the 20-year period, 1891 to 1910, inclusive, that period of time being considered sufficient to establish a satisfactory average, and are therefore comparable as to the period of time covered, and they are also presented in the local standard of time in use at the several stations.

As the variations in elevation at the different stations are such that a chart showing the average velocities without regard to the elevation of the instruments above ground would be without value, an attempt has been made to correct the recorded velocities at each station to the velocity it is estimated the wind would have attained at a uniform elevation of about 100 feet above the earth's surface.

CHANGES IN VELOCITY DUE TO ELEVATION.

Observations of the wind velocity at various elevations above the ground show that near the earth's surface the velocity increases rapidly with increasing elevation. In the vicinity of the Salton Sea, Cal., observations of the wind velocity for various elevations made in connection with certain evaporation investigations showed that from the earth's surface to an elevation of 10 feet the increase in the average hourly velocity was at the rate of about 17 miles per 100 feet, from 10 to 20 feet the increase was at the rate of about 10 miles per 100 feet, and from 20 to 40 feet the rate of increase diminished to about 7 miles per 100 feet, while from observations made at the top of the Eiffel Tower, at Paris, the rate of increase from an elevation of about 70 feet above the earth's surface to the top of the tower, 1,000 feet, averaged about 1.6 miles per 100 feet.

A comparison of the wind velocities at a number of the stations of the Weather Bureau where changes in elevation have been made, both before and after removal, with the records from near-by stations whose elevations have remained unchanged, together with data from a few stations where at time of removal comparative records were made for short periods at both exposures, indicates that from about 50 feet to 100 feet elevation the hourly rate of increase averages about 3 miles per 100 feet, and from 100 to 200 feet the average increase in velocity has been estimated as at the rate of 2 miles per 100 feet. It is probably true that near large bodies of water and over the level prairies the rate of increase in wind velocity at the lower elevations is much less than for corresponding changes over the broken, hilly, and wooded parts of the country, but at the present time it is not feasible to attempt to differentiate between these exposures. In preparing the accompanying charts the records of wind velocity at the various stations in the United States have therefore been corrected to a common elevation of 100 feet above the ground by applying a positive correction to the observed average hourly velocity at the rate of 3 miles per 100 feet at all stations where the wind instruments are exposed at from 50 to 100 feet elevation, and a negative correction at the rate of 2 miles per 100 feet at stations with elevations greater than 100 feet. At but few of the stations is the elevation less than 50 feet, and likewise but a small number have elevations exceeding 200 feet.

In view of the fact that in the large cities the expanse of buildings acts in the same manner as the earth's surface in retarding the progress of the winds, thereby raising the general surface to the average level of the roofs of the buildings, it is deemed necessary to make some allowance for that condition. Therefore, in the largest cities, 500,000 population or over, it is estimated this factor is equivalent to 50 feet elevation, and in cities from 100,000 to 500,000 population it is estimated at 25 feet, and a corresponding correction has been applied to the records.

It must be understood, of course, that all these corrections are largely estimates, and a closer study of the question may show that for certain stations or areas the corrections are in error, since it is well known that the wind velocity is greatly influenced by local topography, such as the trend of the mountains and the configuration of the land and water areas, giving rise to currents of widely different velocities at even near-by points, or modifying materially the rate of increase with elevation, and it is recognized that these conditions should be considered as far as practicable in reducing the discordant values to a comparable basis.

HOURLY VELOCITIES.

A glance at Plate XXIII, "Average hourly wind velocities," clearly shows the effects of elevation, of proximity to large bodies of water, and of the open, level plains in the increased wind movement. Along the Atlantic coast the alternating land and sea breezes carry the average velocity for the entire year beyond 10 miles per hour, and for exposed points and for certain months of the year the wind attains average velocities as high as 16 and 18 miles per hour. Similar conditions prevail along the Great Lakes, where, near the shore line, the average velocities rise to 10 and 12 or more miles per hour. Likewise, along the Gulf coast the wind attains considerable average velocity.

On the Pacific coast the sea breezes are usually quite moderate from central California southward, the average velocity at San Diego being less than 6 miles per hour. On the middle and north Pacific coast, however, extremely high winds prevail at times, and at some of the headlands along the immediate coast of central California the average velocity of the wind exceeds that registered at the summit of Pikes Peak, Colo., at an elevation of more than 14,000 feet above sea level.

HIGH WINDS ON THE MIDDLE PACIFIC COAST.

At Point Reyes, Cal., a small peninsula jutting into the Pacific Ocean a short distance north of the Golden Gate, the average annual velocity of the wind at an elevation slightly exceeding 500 feet above sea level and less than 50 feet above the ground reaches 20 miles per hour, and during some months of the year the average velocity is more than 25 miles per hour.

Among some of the remarkable winds that have occurred at that point may be mentioned the storm period of May 15 to 20, inclusive, 1902, during the entire 6 days of which the average wind velocity exceeded 50 miles per hour, and for a period of 24 consecutive hours it blew at the rate of nearly 80 miles per hour, with a maximum velocity for a 5-minute period of 110 miles and an extreme velocity at the rate of 120 miles per hour. Likewise, during May, 1903, the velocity averaged more than 50 miles per hour for 9 consecutive days—May 14 to 22, inclusive.

WINDS OF THE GREAT PLAINS.

Over the Great Plains region from the Dakotas to Texas the average wind velocities approach those near the seashore, ranging from nearly 12 miles per hour in North Dakota to more than 15 miles in the Panhandle of Texas. The wind movement in the above region is highest as a rule in April and lowest during midsummer, the average velocity for April exceeding that for July by from 25 to nearly 50 per cent.

WINDS IN MOUNTAIN REGIONS.

In the protected valleys of the Appalachian Mountain region the winds are usually light, generally less than 8 miles per hour, but at exposed points, especially in the northern portions, the velocities are much higher; indeed, the highest wind velocities in the United States are probably registered at the top of Mount Washington, N. H., elevation about 6,300 feet, where even during the summer months the average hourly velocity exceeds 25 miles, and in winter, under the influence of the cyclonic circulation, due to its location in the path of nearly all the storm tracks that cross the United States, the average velocity rises above 30 miles per hour. These high velocities do not prevail throughout the entire elevated portions of the Appalachian Mountain region, however, but diminish rapidly toward the south. At Mount Weather, Va., elevation slightly more than 1,700 feet, the average velocity in January is 18.3 miles per hour, and in July it is but 11.7 miles; while at Mount Mitchell, N. C., elevation 6,700 feet, about 400 feet higher than Mount Washington, the average velocity during the summer months appears to be but slightly more than 10 miles per hour. Likewise, in the mountain and plateau districts of the West the wind velocities at the less-exposed points are quite low, while at the extreme elevations the velocities are not so high as at Mount Washington, and are but slightly higher than those near the sea level at exposed points on the middle and north Pacific coast. The average velocity for the year on Pikes Peak, Colo., elevation 14,134 feet, is but 22.2 miles per hour, falling to an average of 13.5 miles in July and rising to 27.1 miles in March.

DAILY MARCH OF THE WIND.

The average daily march of the wind near the earth's surface for each hour of the day and each month of the year is shown for two representative stations, one on the eastern seacoast and the other in the middle Plains region. (See figs. 9 and 10.) In both cases the action of the sun's heat in accelerating the wind movement is graphically shown, the wind rising regularly with the increased power of the sun's advancing heat and falling with the lessening effect of its declining rays. Near the earth's surface the average increase in wind movement during the daylight hours, over those of the night time, ranges very generally from 20 to 40 per cent, and in exceptional cases the increase is 50 per cent or more above the average

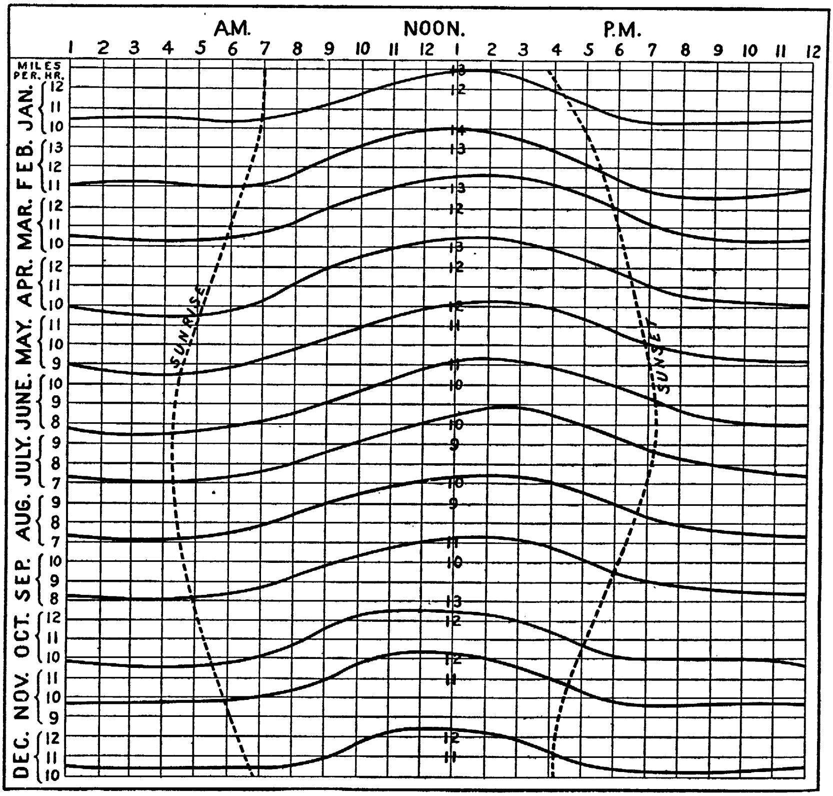


FIG. 9.—Diurnal march of the wind near the earth's surface, seacoast station, Atlantic City, N. J. Local standard time.

night velocity. A few exceptions to this rule occur near the Pacific coast where, on account of small temperature changes or the effect of local air drainage, the night velocities are equal to or slightly greater than those of daylight. For the upper elevations the daily march of the winds is reversed from that near the surface, the elevation at which this reversal takes place varying with local conditions, and the night velocities exceed those of the daylight hours. Figure 11 shows the hourly values for Pikes Peak, Colorado, and similar results are shown in the records from Mount Washington, New

Hampshire; Mount Mitchell, North Carolina; and Mount Tamalpais, California. At Mount Mitchell the velocity at noon is but slightly more than 50 per cent of the midnight velocity, and at Mount Tamalpais similar conditions exist, while at Pikes Peak and Mount Washington the midday winds are from 75 to 85 per cent of their velocity at midnight.

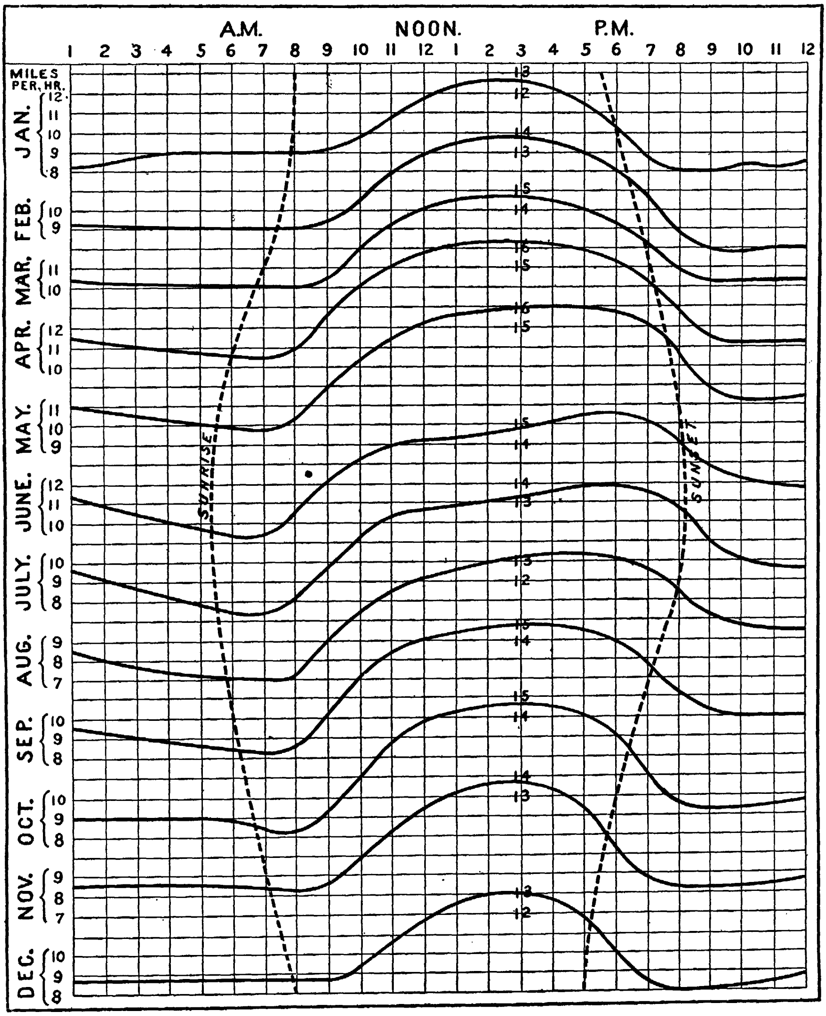


FIG. 10.—Diurnal march of the wind near the earth's surface, inland station, Dodge City, Kans. Local standard time.

WINDS DURING THE DAYLIGHT PERIOD.

Plate XXIV shows the average hourly velocity of the wind during the daylight hours, 6 a. m. to 6 p. m. During this period the average velocity of the wind rises to 10 miles per hour or more over large areas of the country and passes above 14 miles per hour in portions of the Great Plains region and above 15 in the Panhandle of Texas, the western portions of Oklahoma, and in parts of North Dakota. Along the shores of the Great Lakes it is above 10 miles and exceeds 12 miles per hour at exposed points, while at points on the Atlantic and Pacific coasts the average velocity is in excess of 16 miles per hour.

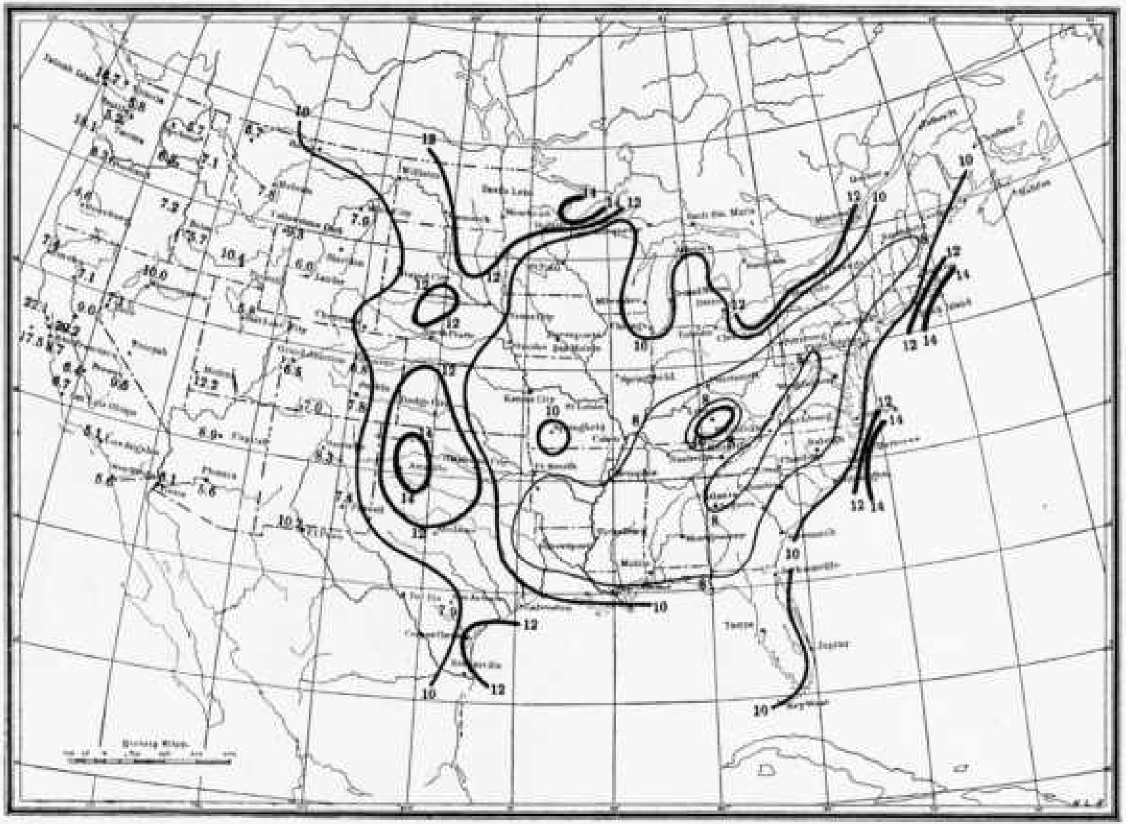
In the protected valleys of the Appalachian Mountain region and in the interior of the Gulf States the average velocity is somewhat less than 10 miles, and similar velocities appear on the south Pacific coast and in the protected valleys of the western mountain and plateau districts.

EXTREME DAY AND NIGHT VELOCITIES.

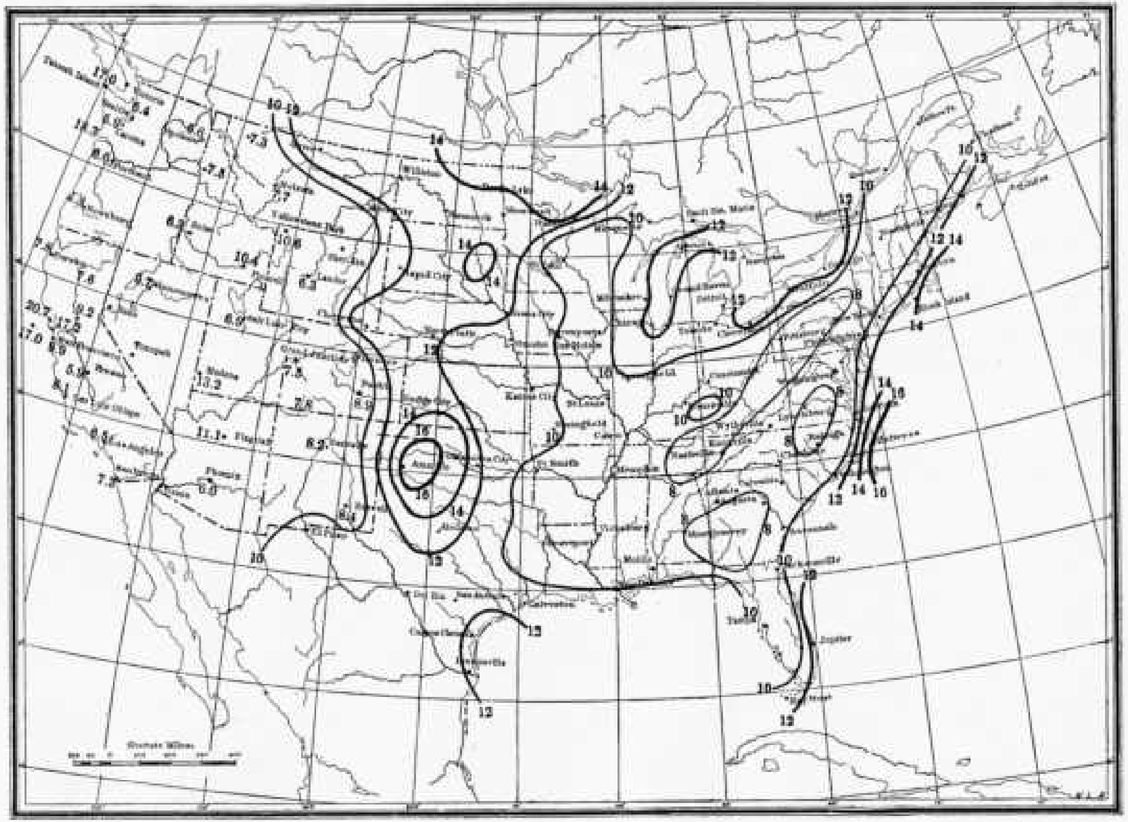
Plates XXV and XXVI show the average velocity at 3 p. m. and at 6 a. m., respectively, local time, these being the approximate hours of maximum and minimum wind movement. The marked difference in the velocities shown on these charts is apparent when the areas above and below an average of 10 miles is considered; in fact the increase of the winds near midday over those near sunrise averages generally more than 50 per cent of the lower velocity, but ranges from more than 100 per cent down, depending upon the location of the station and its environments. Along the immediate Atlantic coast this increase is quite small, ranging from 10 to 20 per cent, and it is likewise low on the lower lakes and to a less extent on the upper lakes and on the Gulf coast. On the Pacific coast it ranges from 151 per cent at San Diego to —3 per cent on the extreme northwest coast of Washington, with marked variations on the middle Pacific coast. At San Francisco, Cal., the average velocity at 3 p. m. exceeds that at 6 a. m. by 146 per cent, while at Point Reyes the 3 p. m. velocity is 5 per cent less than that at 6 a. m. The increased velocity of the early afternoon winds over those of the early morning is most pronounced in the regions of light winds. In the protected valleys of the Appalachian and Rocky Mountain regions this increase ranges from 75 to more than 100 per cent, while over the Great Plains, where, generally, high average velocities prevail, the increase is much less, generally from 30 to 50 per cent.

CHARACTERISTIC WINDS.

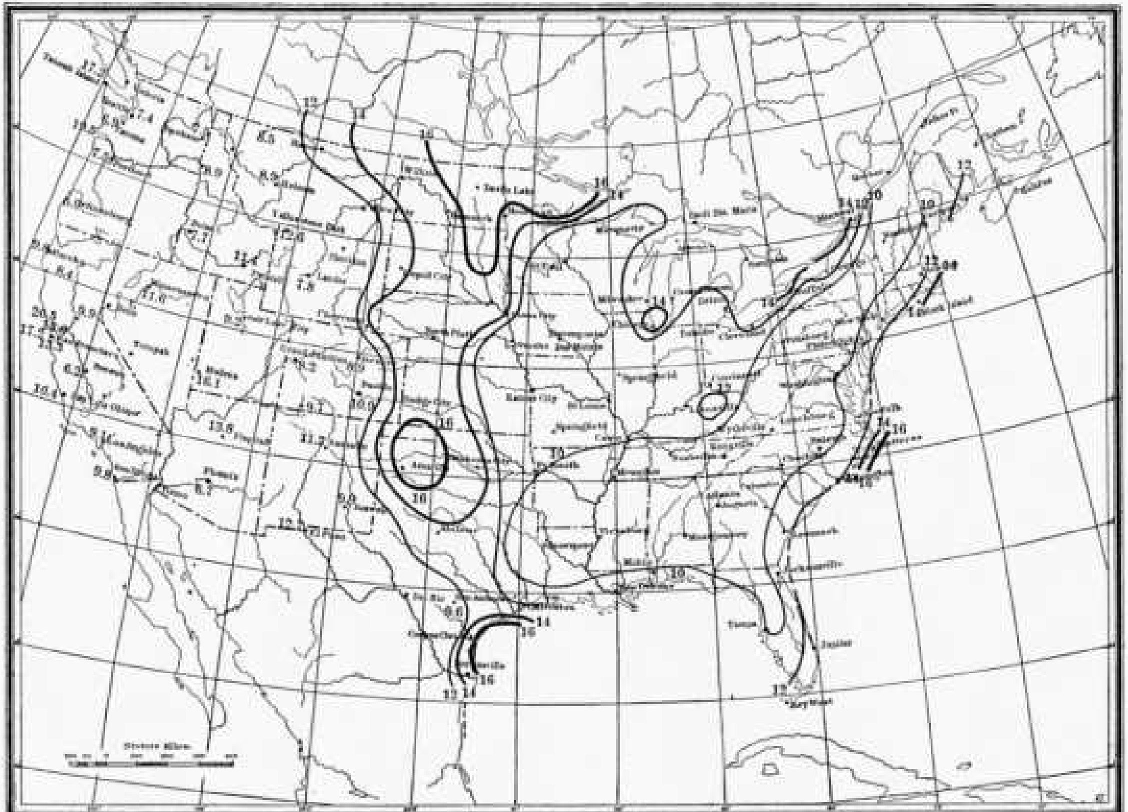
The geographical location of the United States is such that the greater part of its territory lies within the path of the general westerly winds common to its latitudes, and but for the obstructions offered by the mountain ranges, hills, etc., the influence of the large bodies of water, and the variations of atmospheric pressure due to the movements of cyclonic and anticyclonic storms, the surface winds would exhibit a general movement from some westerly point, save over the extreme



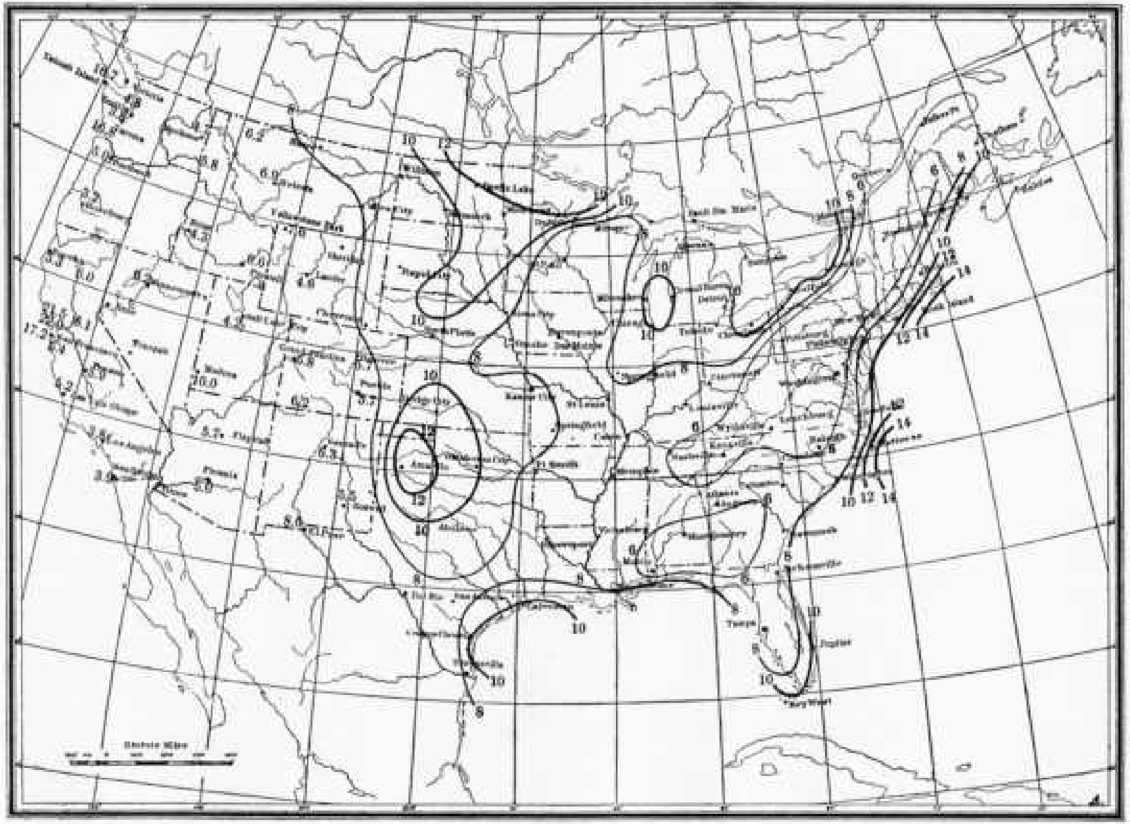
AVERAGE HOURLY VELOCITY OF THE WIND. ESTIMATED FOR ELEVATION OF 100 FEET.



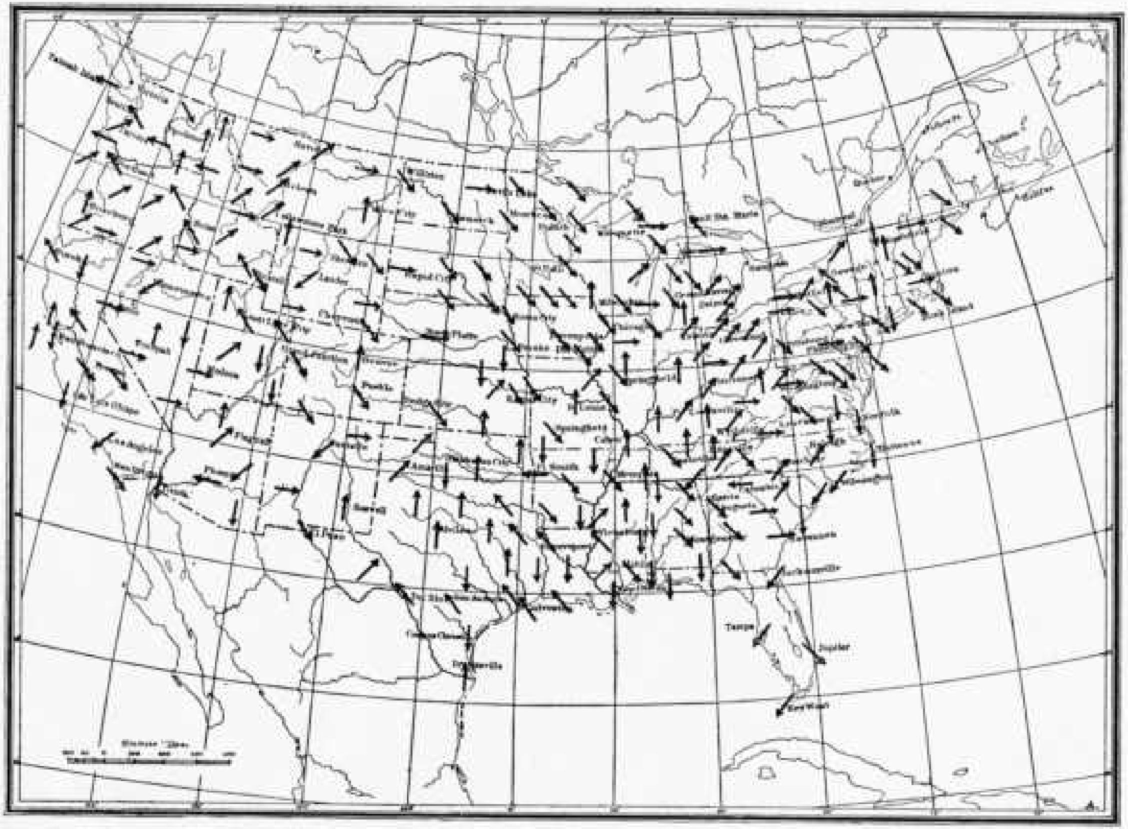
AVERAGE HOURLY VELOCITY OF THE WIND, DAYLIGHT HOURS, 6 A. M. TO 6 P. M., LOCAL STANDARD TIME.
ESTIMATED FOR ELEVATION OF 100 FEET.



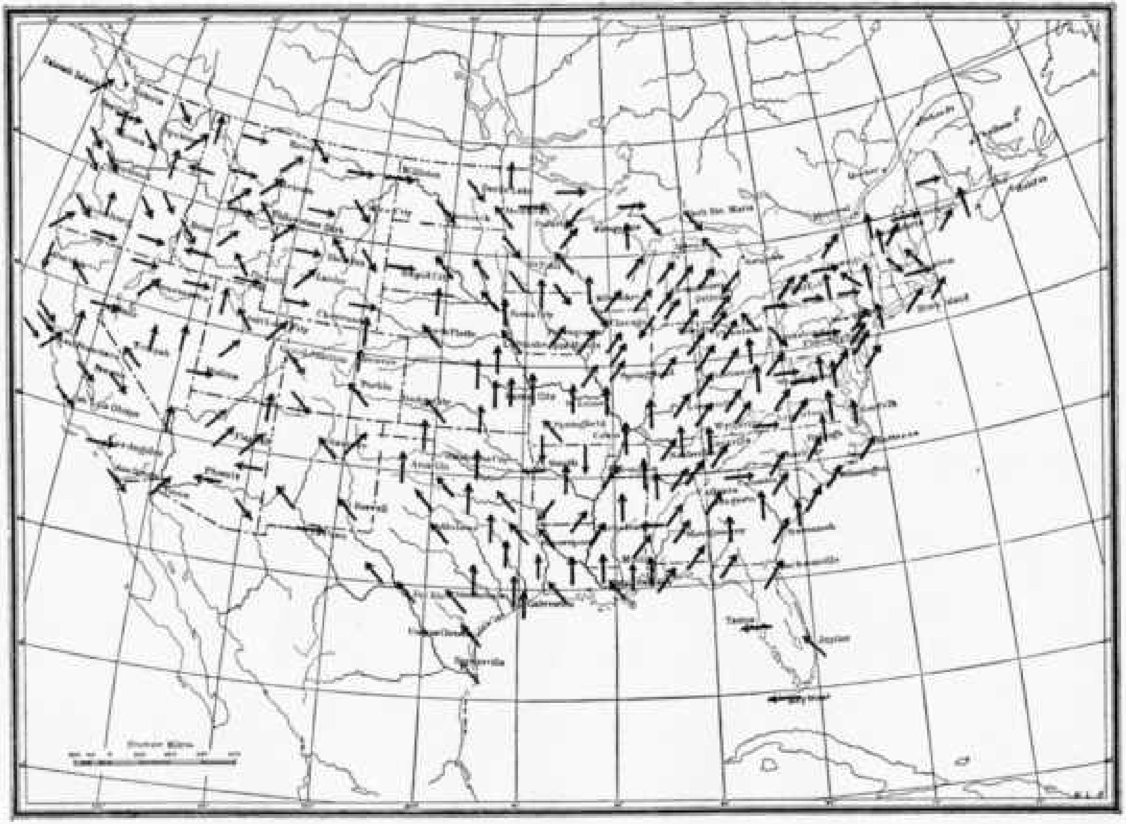
AVERAGE HOURLY VELOCITY OF THE WIND AT 3 P. M., LOCAL STANDARD TIME, THE APPROXIMATE HOUR OF GREATEST WIND MOVEMENT. ESTIMATED FOR ELEVATION OF 100 FEET.



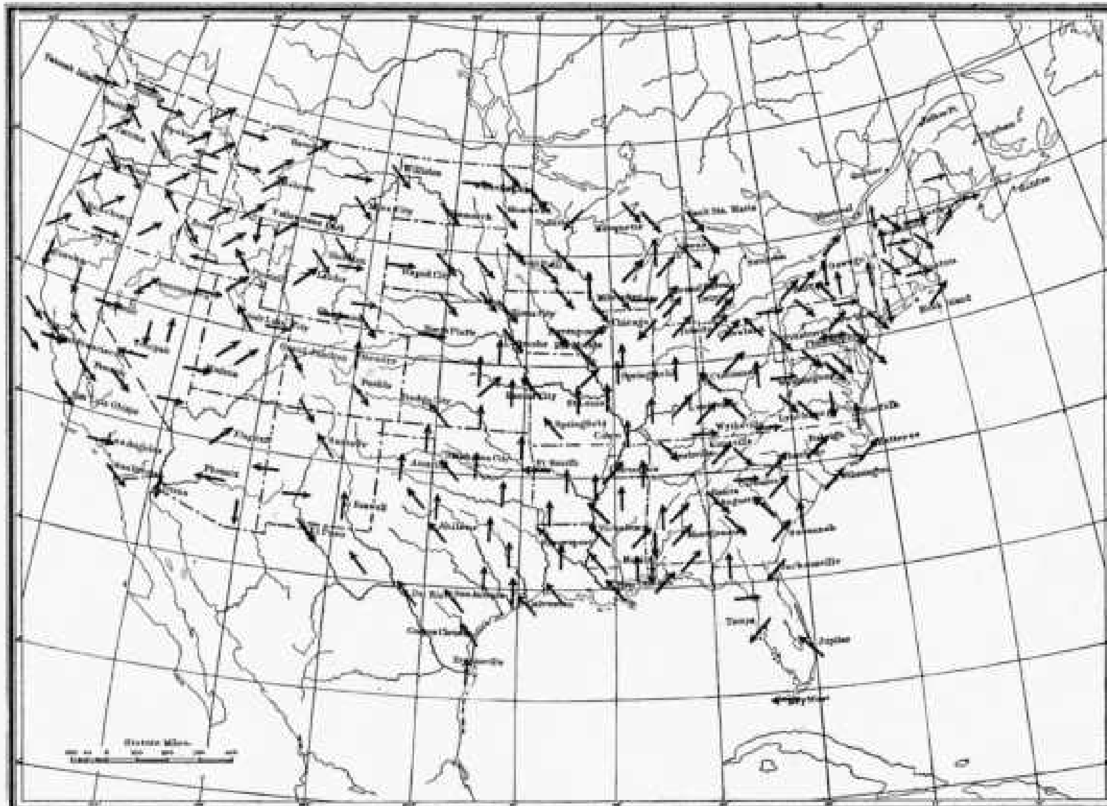
AVERAGE HOURLY VELOCITY OF THE WIND AT 6 A. M., LOCAL STANDARD TIME, THE APPROXIMATE HOUR OF LEAST WIND MOVEMENT. ESTIMATED FOR ELEVATION OF 100 FEET.



PREVAILING DIRECTION OF THE SURFACE WINDS, JANUARY.



PREVAILING DIRECTION OF THE SURFACE WINDS, JULY.



PREVAILING DIRECTION OF THE SURFACE WINDS, FOR THE YEAR.

southern portions, where the northeast trade winds prevail at certain periods of the year. On account of these interferences with the general drift of the atmosphere, there are developed systems of winds more or less persistent as to seasonal occurrence and geographic limits.

The different rates at which the land and water surfaces absorb and lose the sun's heat cause, near the shore line of large bodies of water, the well-known land and sea breezes, and we have these reversals of wind movement in the immediate vicinity of the several coasts and in the lake region. The prevailing trend of the wind along the coasts is, however, from some westerly point, except along the Gulf and south Atlantic coasts, where the effect of the trades begins to be felt, and the trend is from the south and east.

In the northern Plains region and upper Mississippi Valley west to north winds prevail, penetrating well into the middle plains and middle Mississippi Valley during the colder months of the year, but receding far to the northward during the summer months.

In the west Gulf and southern Plains regions southerly winds predominate, their sphere of influence, however, extending far to the northward and northeastward with the advance of the warm season; in fact, by midsummer they prevail throughout the entire country east of the Rocky Mountains, save for small areas from the northern mountains eastward to the Great Lakes, where they continue from the west or northwest. With the return of winter they recede to the southward, and by January their sphere of influence is largely limited to the southern Plains region and portions of the Ohio Valley.

On the Pacific coast, save for the rather slight land and sea breezes, the winds are normally from some westerly point, while in the mountain regions the winds, though generally from some westerly point, are nevertheless greatly modified by local environment.

SPECIAL WINDS.

In addition to these more or less permanent winds there are others uncertain as to occurrence but possessing such marked features as to have assigned to them names which are supposed to denote something of their character.

Among these may be mentioned the "blizzard," an occasional winter visitor to the northwest region, intensely cold and of high velocity, sweeping suddenly from the northward over the Great Plains and upper Mississippi Valley, and in exceptional cases extending far to the southward and eastward, sometimes lasting for several days, in other cases of short duration only. These storms are frequently accompanied by snow and sleet, and the frozen ice crystals, driven by the fierce strength of the wind, together with the accompanying severe cold, force man and beast to quickly seek shelter or face probable death.

Directly opposed to this terror of the Northwest is the "chinook," a warm and generally dry wind, peculiar to mountain regions, but in this country applied to certain winds of winter that occasionally occur in the northern Rocky Mountain and other northern regions, their influence at times extending far into the surrounding plains.

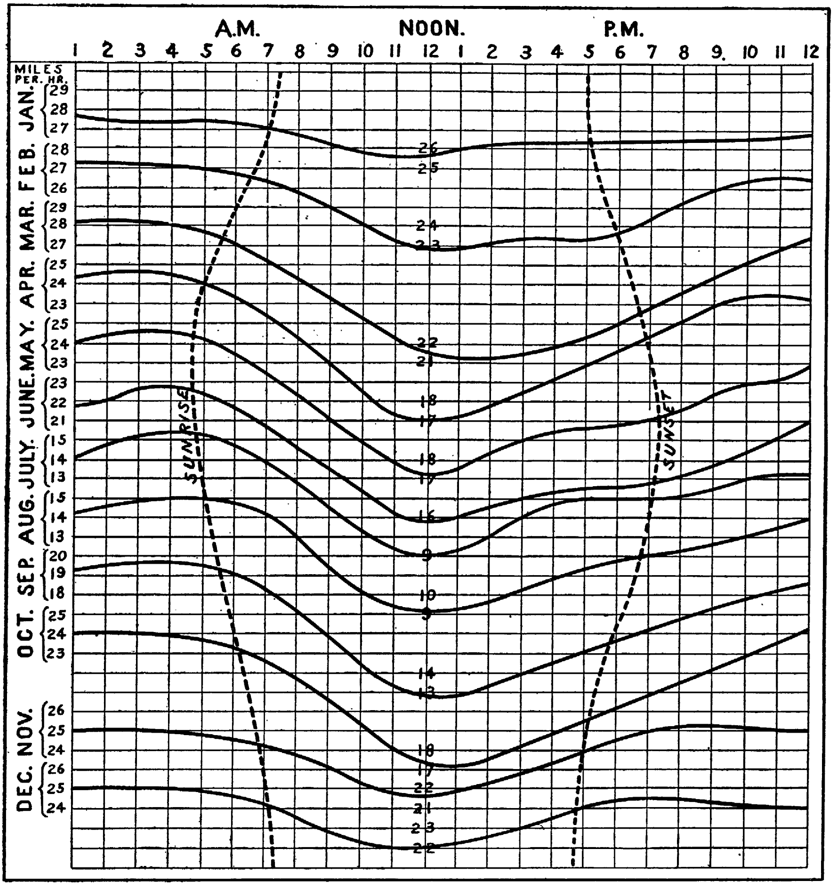


FIG. 11.—Diurnal march of the wind at an elevated station, Pikes Peak, Colo. Local standard time.

These winds frequently follow within a short period after the occurrence of a blizzard, and the first gentle touch of their warmth is like a summer zephyr as compared with the intense cold that may have been previously prevailing. They begin usually as light breezes, but frequently increase to high velocities, their warmth and general dryness rapidly melting or evaporating the accumulated snow and making it possible for domestic or other animals, exposed without shelter, to secure food and obtain rest from their fight against the cold. Were it not for the occasional occurrence of these warm winds animal life could not survive the severe winters of that region without special protection and an adequate supply of stored food.

Over the southern Plains region and sometimes extending into the middle Plains States, occasional "hot winds" occur during the warmer months of the year, blowing generally from the southwest with considerable force, and in extreme cases they have been described as similar to a blast from a hot furnace, absorbing the moisture from the soil and literally drying vegetation as it stands in the fields. Immense damage may be caused in a few hours by these winds at critical periods of crop growth and development, and if continued over several days, as sometimes happens, the suffering to human and animal life from the abnormally heated atmosphere may be intense, and the damage to crops so widespread as to constitute a National calamity. A similar dry, hot wind, the "Santa Ana," occurs at intervals in portions of California, blowing from the north, however, and occasionally causing much damage to vegetation.

ECONOMIC USE OF THE WIND.

Space in this paper will not permit of showing all the uses to which the winds may be put economically to serve the needs of man, but it is hoped the accompanying charts will furnish the means whereby those seeking information as to the possibilities of utilizing their force as a cheap source of power may have before them some of the more important details as to the average rate of motion in the different portions of the country, the time during which certain velocities may be maintained, their prevailing directions, etc.

Air in motion is a vehicle of energy whose power depends upon its rate of movement. It has been a potent agent in the work of leveling the mountains and filling the valleys of the earth by sweeping from the one to the other the loose fragments of rock disintegrated by the action of the elements, and great areas of the earth's surface have been covered to varying depths by this action. It transports the moisture from the sea to the land, watering the earth and forming the rivers. It scatters the seeds of plants and trees far and wide, and thus fosters the distribution of vegetable life.

In our own country the westerly winds, laden with moisture evaporated from the wide expanse of the Pacific, deposit their load largely on the sides of the Sierra Nevada and Rocky Mountains and their outlying ranges. Much of this moisture falls as snow and the winds sweep and pack it into the depressions, where it lies till late in summer, furnishing a supply of water to feed the streams and reservoirs used to irrigate the large areas of orchard and garden in the valleys below. East of the mountains the southerly winds of the spring and summer transport the moisture evaporated from the Gulf of Mexico to the Great Plains and Mississippi Valley regions, where, in the form of rain, it waters the great cereal and grass producing areas. Likewise the valleys and hills of the eastern districts are watered in turn by the moisture-laden winds from the Great Lakes, the Gulf, and the Atlantic.

Man has made use of this force to a greater or less extent from the earliest periods of history by harnessing it to perform useful work. The development of a knowledge of its power may be observed by comparing the rude sail raised by primitive man to assist him in propelling his dugout across a small stream or from island to island with the full-rigged ship of the present day, as she proudly moves from some great harbor, laden with a mighty cargo, to cross the widest ocean. Likewise may we compare the cumbrous wooden windmills of the earlier settlers of our own country with the powerful steel mills of the present day.

The uncertainty of continuous or sufficient wind movement when urgently needed has always militated against a more extensive use of this natural source of power in labor-saving devices, but there is much work that can be economically performed by the wind had we a better knowledge of the regions where its force and constancy are such as to warrant the development of its power.

While the windmill as a power producer appears to be in successful operation in nearly all parts of the country, there are certain sections where the average wind velocity near the earth's surface is so low that only the very lightest character of work can be accomplished, and during much of the time no work at all is possible. On the other hand, there are large areas where its strength is such that mills may be relied upon to furnish power of large volume and with considerable constancy.

LOCALITIES FAVORABLE FOR SUCCESSFUL USE OF WINDMILLS.

The greatest field at the present for the successful use of the windmill as a power producer must be found upon the farms and in the smaller communities farthest removed from other sources of cheap power producers, and with the increasing cost of wood and coal the use of the windmill as a producer of heat, light, and power must ever increase.

A study of the several charts of average wind velocity discloses many regions where the movement, during the working hours of the day, or in some cases for the entire day, is sufficient to insure the generation for much of the time of sufficient power to perform many of the lighter forms of work on the farm or in the household, and thereby warrant the expense of installing the necessary apparatus.

In the Great Plains region of the West, where the lack of rainfall, even under the most favorable conditions of improved tillage, the conservation of the soil moisture, and the growing of drought-resistant crops renders general farming operations somewhat hazardous, it is essential that small areas at least shall be made practically immune from drought by the practice of irrigation. Water may be found at no great depth from the surface in nearly all these regions, and the installation of a small pumping plant operated by wind power will enable the small or large farmer, at little cost, to irrigate a few acres of garden or orchard, thus assuring himself against a total failure of foodstuffs in years of extreme drought. In fact, there are but few portions of the country where intensive farming is practiced that a small irrigating plant maintained by wind power would not at critical periods, when from lack of moisture immense damage might occur, prove a valuable adjunct to the more extensive field operations. Along nearly the entire coast line of the country, at the higher elevations in the mountain districts, and over much of the great prairie regions of the country the velocity of the wind during some portion of the day is nearly always such as to produce power sufficient for the lighter forms of work.

DEVICES FOR OBTAINING ELECTRICAL ENERGY FROM WIND POWER.

One of the most promising fields, however, for the future successful development of power from the use of the windmill lies in the possibilities of successfully generating and storing electrical energy, which may be used later for the heating and lighting of country or suburban homes, charging electrical motor cars, working agricultural machinery, cooking and other household work, and pumping water for irrigation purposes. Electric turbines of this character are now in successful operation, especially in England, and there is evidently a wide field of usefulness open to them in this country, especially in view of the fact that it is probably feasible to connect a number of mills to a single storage battery, thereby greatly increasing its power capacity, and at the same time it is possible to store up the energy generated during periods of abundant power for use during intervals of lack of wind.

Other devices for the development of electric power from the winds provide that, in order to insure the delivery of a certain amount of energy constantly, the windmill shall be supplemented by a combustion-driven engine, the principle being that when the wind is sufficiently strong the electrical generator will be driven by that power alone; when the velocity falls to a point insufficient to cause the generator to deliver the output required, the engine is automatically started and continues to drive the generator until the wind velocity has again reached a point where it can deliver the required power, when the combustion engine is automatically cut out and shut down.

The accompanying charts should prove valuable in showing the portions of the country where such outfits might be economically and successfully installed.

THE WINDS AND AVIATION.

One of the greatest uses of the wind in the past has been in the navigation of the seas, but water is not man's natural element, and after ages of effort it is now apparent that the navigation of the air, man's natural element, is assured.

The information shown on the charts herewith relative to the wind velocities and directions near the earth's surface should be of interest to aviators, especially as to the periods of the day when the air is least disturbed by ascending or descending currents.

The effect of the increasing heat of the sun as the day advances is to warm up the earth's surface and the layers of air resting thereon. As heated air expands and therefore becomes lighter it rises, and there are set up during the hours of sunshine ascending currents which rise in height proportional to the degree of heating. In the summer time the height to which these currents ascend may be indicated by the tops of the cumulus clouds which are formed by the condensation of the moisture in the surface air, which, as it rises to the higher elevations, cools sufficiently by expansion to form clouds. With the approach of night the earth cools rapidly and likewise the layers of air resting thereon. This cooling causes contraction, and as air from above descends to fill the space there results a general descending movement of the atmosphere during the night hours. This night motion is not so pronounced, however, as the ascending day currents, and the vertical stability of the air is greatest during the coolest part of the day.

It is especially important that aviators should escape these ascending and descending currents as far as possible. This can be accomplished in a measure by rising to the higher elevations during the heated portions of the day, while during the early morning and late afternoon hours it is feasible to fly much nearer the earth's surface.

The accompanying charts of average wind velocity and prevailing direction should prove valuable in selecting localities best suited for experimental work in aviation.