resultant of these two vectors. Second step: Turn the protractor and set E on the line OR, and mark the point C on the protractor at a distance of 8 (length of third vector) from the point B parallel to the line OR. By this step parallelogram OBCM is formed with OB and BC as sides and OC as the diagonal. Keeping in mind the parallelogram law, it is obvious that OC is the resultant of the vectors N–5, NE–6, and E–8. Perhaps this may be seen more readily by referring to the polygon law. Considering the polygon OABC, it is clear that OC is the resultant.

When the protractor is turned so that point C is on the initial OR, the length and direction of the resultant is indicated on the scale and the protractor, respectively.

In short, the procedure of compounding vectors by this method amounts to setting the protractor so that the angle or direction of the vector to be considered lies on the initial line of the scale. The length of the vector is then laid off on the protractor from the end point of the preceding vector parallel to the initial line, and its end is indicated by a point, from which the next vector is laid off. The first vector is laid off from the center along the initial line of course. The resultant vector is the line from the origin or center to the end point of the last vector. Both its direction and magnitude are readily determined by placing the end point of the last vector over the initial line.

The millimeter cross-section paper and supplementary scales referred to above enable the operator to determine quickly and accurately the end points of the various vectors when they are far removed from the initial line OR. In this way results of considerable accuracy may be obtained without any computation.

This method of compounding vectors has been in use for the past two years and found to be especially advantageous in determining the mean wind direction; that is, the resultant direction where the strength of the wind is not considered, the various directions being considered as unit vectors.

For obtaining resultant winds, the aerological division has adopted a system suggested by Mr. H. P. Parker, of the aerological station at Broken Arrow, Okla., In this system the sums of the north and west components are obtained by the analytical method, and from these components the resultant direction and velocity of the wind are obtained graphically.

In compounding vectors by either the analytical or the graphical method, opposite directions should be canceled, thereby reducing the number of vectors to be considered.

WHY AN OAK IS OFTEN STRUCK BY LIGHTNING; A METHOD OF PROTECTING TREES AGAINST LIGHTNING

551.594:634

By ROY N. COVERT

[Weather Bureau, Washington, September 2, 1924]

It is desired to consider first what the factors are which determine the relative liability to lightning damage of trees, as determined by their location, the character of the soil in which they grow and its moisture condition, the electrical conductivity of the wood itself, etc.

As a general statement the tree which is a relatively good electrical conductor, and has a root system which is widespread, or which reaches deep into moist soil, is the one which is in most danger of being struck by lightning. No tree is immune, however.

Following are the factors which govern, as determined by careful studies made in western Europe of the effects of lightning on trees:[1]

(*a*) Among trees of the same kind the one which stands well above its neighbors is in most danger, even in a dense forest. This dominant position may be due to the greater height of the tree or be the result of the configuration of the ground.

(*b*) Trees growing in the open, either singly or in small groups, are in more danger than those in the dense forest or other thick stand of timber.

(*c*) Trees growing along avenues or in the border of a wood are also struck by lightning more often than those in thick woods.

(*d*) A tree growing in moist soil—that is, along the banks of a stream or a lake, or close to some other source of moisture—is a better conductor for lightning than one growing in drier soil.

(*e*) Trees growing in loam and sandy soils are struck much more frequently than those in clay, marl, and calcareous soils. Oaks grow mostly in loam and sandy soils.

(*f*) Sound trees in general are less likely to be seriously damaged than those with rotten wood. If the sound tree is also a relatively good conductor, lightning will go to earth easily, but rotten wood is a poor conductor of electricity so that the passage of the lightning current through this nearly nonconducting portion often results in a shattering of the tree and when dry the tree may be set on fire.

(*g*) Starchy trees, of which the oak is a good example, are better conductors of electricity than oily trees like the beech. The conifers are intermediate. Experiments made by Jonesco of the Württemburg Society of Natural Science gave the following results:

One turn of a Holz's electric machine passed the spark through oak wood, five turns through poplars and willows, and 12 to 20 turns through beech.

From the foregoing we learn that an oak is decidedly a good conductor of electricity, so far as trees go; that it grows in loam and sandy soils where trees are most frequently struck by lightning; and, furthermore, it is an excellent example of a tap-rooted tree with its root system extending deep into the soil, all of which qualities place the oak in great danger of lightning damage as compared with other trees. The following question is therefore pertinent:

What do statistical studies of the damage of trees by lightning show with regard to the relative frequency with which oaks are struck as compared with other trees?

The following figures were taken from Schlich's Manual of Forestry, Volume IV, entitled Forest Protection, by W. R. Fisher:

Trees struck in the Lippe-Detmold forest, Germany, from 1874–1890:

	Oak	Beech	Spruce	Pine	Others
Percentage of trees	11	70	13	6	----------
Trees struck	310	33	39	110	30
Relative frequency [1]	60	1	6	37	----------

[1] A previous discussion on kind of trees struck by lightning will be found on pp. 64–69 of Wea. Bu. Bull. No. 26, Lightning and the Electricity of the Air, McAdie and Henry, Washington, 1899.

Results of 15 years of observations published in the Revue des Faux et Forets:

	Oak	Beech	Spruce	Pine	Others
Percentage of trees	11	70	13	6	
Trees struck	159	21	20	59	20
Relative frequency	48	1	5	33	

Observations in the Bavarian State forests, 1887–1890:

	Oak	Beech	Spruce	Pine	Others
Percentage of trees	1.8	10.8	41.5	30.8	15.1
Trees struck	61	7	155	131	
Relative frequency	52	1	6	7	

[1] Relative frequencies are based on 1 for the beech, so that during the period covered by the observations 1 beech tree was struck to 60 oaks, 6 spruce, and 37 pine, each kind of tree being assumed to be present in equal numbers.

Other more recent studies confirm in general the above results, which show that the oak is struck much more frequently than other kinds of trees, with the possible exception of the poplar, which does not appear to have been present in the Lippe-Detmold forest. The list of trees also subject to lightning damage includes the elm, ash, and gum, while those least attractive to lightning are the chestnut, maple, alder, and mountain ash. Those intermediate are the apple, cherry, linden, and walnut, but no tree is immune.

As before stated, an unsound tree containing rotted portions is likely to be damaged to a greater extent than a sound tree, or one which has received surgical treatment, which introduces highly conducting metal into the tree in place of the rotted wood with its low conductivity.

The metal cables and rods quite often used in modern tree surgery to protect the trees against wind damage and decay, while serving in a minor way as conductors and furnishing some protection against lightning, can by no means be considered as a substitute for the thorough protection which it is possible to obtain by rodding, a more recent development than tree surgery. The rodding of trees, especially valuable ones, or those which involve the safety of a building or of animals, is now advocated by the Bureau of Standards, the Weather Bureau, the National Board of Fire Underwriters, the Ontario Department of Agriculture, and others.

In this connection the following is quoted from a new bulletin in process of preparation, entitled "Protection Against Lightning of Buildings and Farm Property":

Protection of trees.—If a building is more or less surrounded by high trees, these trees protect the building to quite an extent from lightning. This is especially true of deep-rooted trees, which are more liable to damage than others. Poplars, oaks, pines, elms, ash, etc., are of this kind. But the trees should be considered only as an additional protection to the building, and the customary equipment should be provided for the latter. Large, full-grown trees near a dwelling are valuable as a rule, and if it is desired to protect them against lightning, a few of the higher ones should be rodded as follows:

Place an air terminal in the top of the tree, but not so high as to be insecure, and ground it through one or two down conductors, the number depending upon the size of the tree. Screw fasteners with a long shank are desirable for holding the down conductors in place along the tree trunk in preference to a rigid fastening. One of the grounds provided for the conductors on the building may be used if convenient, or separate ones constructed at the foot of the trees. In order that a lightning discharge shall not damage the root system of the tree protected, it is generally advisable to construct shallow grounds, essentially as described under "stranded-cable grounds." It is realized that the growth of trees will make it difficult at times to maintain the rodding, and its extension, partial renewal, or repair will occasionally be needed, especially on the younger trees, but less so on the older trees, which change but little from year to year and are probably the most valuable and largest of a group and to be rodded in preference to the others. It is our conviction, however, that the additional protection of both trees and adjacent building often makes the trouble and expense worth while.

SOME FEATURES OF THE CLIMATE OF ALASKA[1]

551.58 (798)

By Melvin B. Summers

[Weather Bureau, Seattle, Wash.]

Less than a generation ago the popular conception of Alaska was that of a land of perpetual ice and snow, infested with polar bears, and inhabited by a race of beings who dwelt in snow and ice houses and subsisted on the blubber and flesh of walrus, seal, and other animals native to a frigid climate. So fixed had this idea become that even to-day, after considerably more than a billion dollars of wealth has been wrested from the Territory through mine, forest, field, and sea, there are those who find difficulty in divorcing these preconceived opinions from their minds.

It is a surprise to many people to learn that tropical daytime temperatures are recorded in Alaska every summer, and that there are parts of the Territory, notably in the Aleutian Islands and along the southern coast, where zero readings have never been observed.

Lying, as it does, north of the Pacific Ocean, with the vast expanse of British America to the east, and separated only by Bering Strait from the larger land mass of Siberia to the west, the main portion of the Territory is covered during the winter by relatively high atmospheric pressure. Over the immediate water surface on the south there usually exists a trough of low pressure with a west-east trend, commonly known as the Aleutian LOW. Through this pressure valley, so to speak, pass a great many of the cyclonic disturbances of the Northern Hemisphere in their west-to-east movement. Other disturbances originate in it and altogether it exercises a great influence on the weather of the Territory as well as on that of the Canadian Provinces to the east and the northern half of the United States to the southeast.

The mountains of British Columbia, with their southeast-northwest trend, present somewhat of a barrier to the eastward movement of these barometric depressions, many of which stagnate in the Gulf of Alaska for days at a time, especially if the Pacific high-pressure area lying to the south manifests a tendency to move northeastward over Oregon and Washington. In fact, after reaching the Gulf of Alaska a cyclonic storm may be forced to pursue a retrograde movement and actually to move northwestward.

Whether from a breaking down of pressure in the Arctic slope of Alaska, or from the northward thrust of the Pacific High, these Aleutian LOWS occasionally take a northeastward movement over Bering Sea and advance toward Seward Peninsula and the Kobuk Valley of Alaska, or they may take a similar direction of movement farther east over the Yukon Valley. So long as the LOWS pursue their normal track over the north Pacific and the Gulf of Alaska, fair and cold weather obtains over the interior valleys of the Territory, with warm and rainy conditions over the southeastern panhandle. When, however, they take a northeastward movement, the temperature of the interior moderates under the influence of southerly winds, and precipitation to a greater or less

[1] Read before the meeting of the American Meteorological Society, Leland Stanford University, June 26, 1924.