METEOROLOGY

Lightning

Though Much Has Been Learned About These Big Sparks of Electricity, Lightning Research Remains Almost Uninvaded

See Front Cover

By DR. FRANK THONE

LIGHTNING, most awesome of the spectacular forces of nature, has yielded some of its mystery to science. But not all. We no longer credit it, as did our ancestors, to an angry Zeus or an impetuous Thor. Since Ben Franklin flew his adventurous kites, nearly two centuries ago, we know it is "made of electricity." We have some idea how it prepares its path through the air. We have found out what almost infinitesimal fraction of a split second it takes for its leap. We guess (though crudely) at the amount of energy in a flash.

But we do not know with certainty what makes its light. We can only infer why it causes thunder. And we are as helpless as were our most scared and benighted forebears at the job of predicting where it is going to strike next. Weather scientists who specialize in lightning can work for many years before they need sigh for more worlds to conquer.

The terrific power for destruction that rides in a lightning stroke was probably what impressed primitive man most and first. If lightning struck a man or an animal, he died instantly. If it fell in the forest, trees were blasted, and very likely a fire started. If it struck the ground, a stone could usually be found that nobody had noticed before—plainly the core of the destructive missile from on high.

So it easily came to pass that the principal god was always the lightning-wielder; Jupiter-Zeus, among the Romans and Greeks, Thor among the peoples of the North. Even Yahveh of the Semites is said to have been originally a weather-god; the attributes of majesty and mercy that made Him King above all gods and finally the sole God came through the inspiration of the patriarchs and prophets of that genius-race in religion, the Jews. And we still see the lightning flashing about Him on the summit of Sinai.

With this savor of the supernatural clinging to lightning through the ages, it is not at all remarkable that real knowledge about the fire in the heavens is almost altogether modern knowledge. Nor is it remarkable that fragments of the old religious awe still survive, furtively, as supersitions. "Thunderstones" are still sent to museums by sincere but mistaken believers in their genuineness. Village atheists still climax tirades by challenging God to destroy them with a stroke of lightning (atheists are usually extremely superstitious). There are still people who believe a marriage will not turn out well if it thunders on the wedding day.

Lightning Superstition

Curiously enough, too, there are lightning superstitions that sprout not from half-forgotten religious sources but from half-understood science. There are nervous women who put the legs of a chair or a table in glass tumblers or bowls and roost cowering on this supposedly insulated perch during a thunderstorm. There are plenty of persons of both sexes who think that "lightning follows a draft" and will not have an open window in the house so long as there are flashes in the sky. And the idea that thunder sours milk seems to be as robustly flourishing as though milk bacilli had never been discovered.

The best cure for superstition is a dose of plain fact. What is a flash of lightning, then; whence does it come and what does it do?

A flash of lightning is simply a big electric spark, leaping the gap between a postitively charged body and a negatively charged one. When you stroke a cat until her fur crackles, you are making lightning on a minute scale. The physicist in the laboratory, turning the handle of a static electric machine until he gets a bigger spark that jumps with a loud snap, is also a small-scale lightning-wielder. It was just to prove this point that Franklin flew his kite into a thunderstorm and charged battery jars with electricity from the clouds.

But where do the clouds get their electrical charge? It is built up by the separation of positively and negatively charged particles. Everything carries an electric charge, even the least dust particle in the air or the smallest raindrop. But most of the time positively and negatively charged particles are mixed in so nearly equal numbers that nothing happens.

But in the windy chaos of a thunderstorm's front, where masses of warm air are rising as violent vertical winds and other masses of cold air are descending with equal violence, a grand sorting-out of charged water-drops occurs. Small drops, bearing negative charges, are whirled aloft on the rising air currents: we get vivid evidence of that in the high-piled "thunderheads" that often form on a hot afternoon. Big drops, carrying positive charges, fall in spite of the up-blowing winds, and form the bottom of the cloud. Thus a thundercloud carries a massed negative charge at its top, a massed positive charge at its base. The ground underneath is usually negatively charged, so that there is a sort of electrical sandwich—positive charge between two negative ones.

Where opposite charges of static electricity exist, there is always a tendency for them to unite and end the state of tension that exists between them. When the charges are powerful enough to break down the insulating effect of the air, they leap the gap as a spark—and if the spark is long enough, it is a flash of lightning.

When we see lightning flash, it is so sudden as to seem outside of time—something done instantaneously. But that is not all there is to a flash of lightning. Before it can leap, there must be a path

prepared for it. This is done by a kind of electric "feelers" sent out from both sides—silent, usually invisible electric discharge that loads a path through the air with sufficient electric charge to make it a conductor. In the language of the laboratory, the air is "ionized."

This path does not go in a straight line, as it theoretically might. This is because of uneven amounts of moisture in the air, influence of the wind, etc. Hence when the lightning discharge itself, suddenly leaps along the path, it makes an irregular streak of brilliance.

Path Not Angular

The path of a lightning flash, however, is not the geometrically regular series of sharp angles in which the older artists seemed to delight. It is as crooked as the course of a brook, or the root of a tree. Indeed, branching streaks of lightning do bear a most startling resemblance to root systems, sometimes.

Lightning does not always leap from the cloud to the earth. Many, probably most, lightning discharges occur betwen cloud and cloud, or even between the top and the bottom of the same cloud. A horizontal, cloud-to-cloud lightning stroke may travel as much as twenty miles. Vertical flashes, from cloud to earth, are seldom as much as a mile in length.

While lightning will occasionally strike the level earth, usually its target is some projecting object—a house, or a tree, or a transmission line tower. This is because the path-preparing brush discharge is more likely to start from a projection than from a level surface.

By the same rule, therefore, the neighborhood of anything prominently projecting is dangerous during a thunderstorm. It is a great temptation to take shelter from the pelting rain under a big tree, but that is the thing most likely to "draw lightning." If you are in the woods, keep away from the tall trees and near the low ones, when the storm breaks. If you are in the fields, and lightning begins to pelt the earth around you, lie down. Then you'll have as much chance at least as the worms and toads and other humble things. If you stand up proudly and assert yourself like Ajax, you're offering a nice little projection for the start of one of these lightning-coaxers, a brush discharge. Ajax may have appealed to Homer, but to a modern meteorologist he was just a darn fool taking an awful chance. He got away with it, so he lives in literature as a hero—albeit a somewhat stupid one.

Indoors, you are safest in a steel-frame building, if the frame is well grounded. Next to that, in safety, is any kind of a building really thoroughly equipped with lightning rods. But most "protected" buildings don't have the job done half well enough. According to Prof. W. J. Humphreys of the U. S. Weather Bureau, there should be a rod, preferably six feet high, on every chimney, gable-end, and other projection. The conductors should be solidly connected with each other and with all plumbing and piping in the house, and should finally be grounded deep in perpetually moist earth. This sort of an arrangement, he says, will not insure against all damage, but it will make a house much safer than one with no rods or with rods carelessly or inadequately installed.

How hard lightning strikes when it does score a hit is shown graphically by a crushed hollow copper lightning rod which Prof. Humphreys has studied. One stroke of lightning did for it, collapsing it completely except for a joint where it was solid for a few inches, and melting its tip off. Prof. Humphreys estimates that roughly 100,000 amperes of electricity dumped itself through this rod in a small fraction of a second.

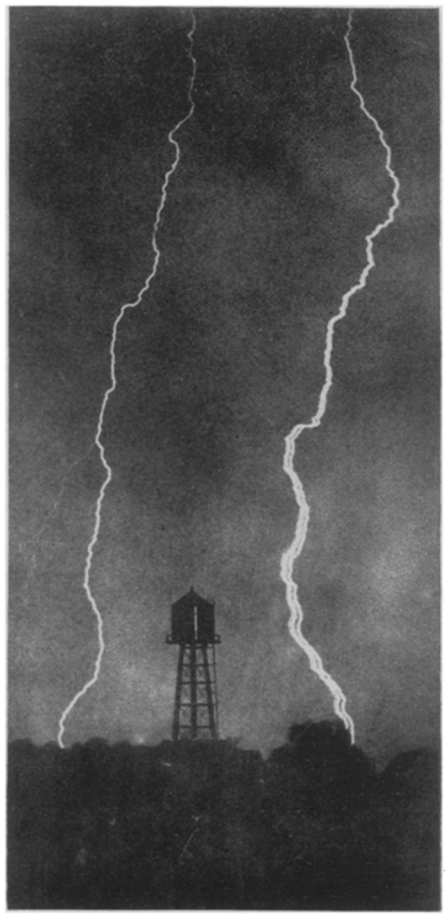
How small a fraction of a second a flash of lightning lasts was for long an unsolved riddle. However, several methods of getting an estimate, most of them involving the use of special cameras, have been used with apparently satisfactory results. Possibly the closest measurement of lightning time was made by Dr. C. V. Boys, noted English physicist, during a visit to this country some time ago. His calculations of one flash he caught with a camera fitted with two revolving lenses indicate a total travel time for the flash of one seven-thousandth of a second. So "quick as a flash" is really pretty quick.

Starts at Ends

An interesting by-product of Dr. Boys' clocking of the lightning was the discovery that the flash started from both cloud and ground at the same instant, uniting in the middle of the path.

What causes the blinding white light of lightning is still pretty much an unsolved riddle. It can hardly be entirely due to the heating of the air, Prof. Humphreys thinks. More likely, he suggests, it is an atomic "excitation" phenomenon, similar to what we see in the glowing Neon-tube signs in the streets.

Lightning is not always of the same color. Some flashes are white or blue-white, others reddish, and sometimes yellow flashes are seen. The white and blue-white flashes, Prof. Humphreys explains, are caused by lightning striking through a rain-filled atmosphere; the light is largely that of glowing hydrogen. The rose-colored flashes are made by lightning striking through dry air. In these, the light is due mostly to nitrogen. The yellow flashes are really white ones, but at such a distance that part of the colors are filtered out of the light before we see it.



MULTIPLE TRACK

The right-hand flash shows clearly how lightning may strike several times along the same path through the air.

The real lightning is always of the "streak" variety. So-called "sheet" and "heat" lightning are simply reflection effects.

The cause of thunder is most plausibly explained by the sudden expansion of the atmosphere along the course of the flash, due to the brief but intense heat. It is in the same category as the sound of a big gun, but it lasts longer because the sound takes some time to travel to us from the more remote parts

of the flash; and the effect is aggravated by the crookedness of its path.

It is easy to tell how far away a lightning-flash started, by listening for the first thunder-sound. As soon as you see the flash start counting, somewhat deliberately, "One hippopotamus, two hippopotamus, three hippopotamus. . . etc." It takes about one second to say "One hippopotamus." Sound travels about a thousand feet a second. Allow a mile for every five hippopotamuses.

PICTURE ON THE COVER—Black lightning, which appears in some photographs but is never observed visually, is not really dark. The black streaks are the weaker flashes that have a brightness value so low, in contrast to the brightly illuminated background, that they appear dark by comparison.

Science News Letter, June 24, 1933

CRIMINOLOGY—PHYSIOLOGY

Real Detective Stories Told in Medical Exhibit

SOLUTIONS of dozens of real life detective stories were exhibited at the meeting in Milwaukee of the American Medical Association.

Two slender vials, for instance, contain the sleeping medicine found in the organs of Starr Faithful, New York society girl who mysteriously disappeared from an ocean liner. When her body was found in the water, the condition of the heart showed death by drowning, but discovery of the sleeping medicine, veronal, in all the organs showed that she must have been in deep sleep when her body reached the water and that she could not have jumped in.

Nearby are pictures and diagrams of gunshot wounds. From the condition of the edges of the skin and from the size of the entering and exit holes of the bullet much can be told of how and from where the shot was fired.

A picture of the charred remains of a torch murder victim and pictures of the teeth and jawbones by which the victim was identified are to be seen. Exact description of the teeth was sent by the police to thirty thousand dentists, from which identification was made.

But the purpose of the exhibit is not to make a chamber of horrors display, although that is the effect. Instead it is to call attention to the value of trained medical examiners in place of coroners for determining the causes of accidental or sudden deaths.

Science News Letter, June 24, 1933

ENTOMOLOGY

Grasshopper and Locust Plague Declared Largely Man-Made

MAN HAS himself to thank for plagues of grasshoppers and their next of kin, the locusts. An international scientific accord on this point was reached at the Fifth Pacific Science Congress in Vancouver, B. C., by Dr. J. R. Parker of the U. S Department of Agriculture, and Dr. B. P. Uvarov, of the Imperial Institute of Entomology, South Kensington, England.

Dr. Parker, discussing conditions in the grasshopper areas of North America, gave it as his opinion that the cultivation of crops of lush vegetation alongside of unplowed roadside and fencerow strips that offer ideal hatching grounds for grasshoppers tends to make these insects more numerous than they were in the days of unbroken sod, before agriculture came. We must therefore calculate upon grasshoppers as a perennial pest, he said, and adjust our farm practice and methods of anti-insect warfare accordingly.

Dr. Uvarov was concerned primarily with the locust problem in Asia and the adjacent island areas. China, he said, offers the greatest menace on the mainland: an intensively cultivated agricultural country where coordinated scientific control of the insects is not yet a possibility.

The Philippines and the East Indies, he said, present a challenge to the Western powers that control them to unite in an international effort to end the locust menace, as several of the European powers already have united to fight the insects in the Occident and the Near East. The introduction of semi-Europeanized farming methods in the various island groups has resulted in a shifting agriculture, leaving abandoned fields as breeding grounds for locusts, which subsequently rise in migrating swarms and often cross considerable stretches of sea to fall on other islands under the jurisdiction of other powers. Dr. Uvarov pointed out a special responsibility of the United States in this connection, since the Philipines are under suspicion as particularly prolific breeding grounds of migratory locusts.

Science News Letter, June 24, 1933

BACTERIOLOGY

Cause of Fatal Disease In Young Lambs Discovered

DURING the California lambing season, a disease hitherto of unknown origin inflicts heavy losses upon newly-born lambs on farms that are widely separated.

Dr. Hilda Hempl Heller of the Hooper Foundation for Medical Research of the University of California, has fastened the apparent guilt of causing this disease upon one kind of the very common colon bacilli, the sort of germ widely found in the intestinal tract of animals.

An unusual circumstance of this disease is that, though it is an infection, the mechanism of its action resembles that of a food poisoning. The little lamb, just after being born, drinks its mother's milk, which is not poisonous. When in some way it is infected with the colon bacillus at a virulent stage, the germs form a poison in the milk within the lamb's alimentary tract. The lamb dies from absorbed poison rather than from the direct attack of the germs.

The germs charged by Dr. Heller with causing the disease are extremely variable and they have been found to change their deadliness rapidly.

Dr. Heller, who is an authority on botulinus poisoning, began work on the disease because it was thought that it was a disease caused by an anaerobe, or air-hating germ. She found that a powerful poison was present in the lamb's intestines, of which five drops would kill a mouse in two and one-half hours. The blame for forming this poison could not be fastened upon any anaerobe.

The poison-producing power of the