LIGHTNING IN ACTION

by F. BARROWS COLTON

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LIGHTNING, with its terrible destructive power, has been rightfully feared by man for countless ages. For most of that time he was helpless against this terrifying attack by Nature's forces. But today this age-old enemy is being at least partially tamed.

Lightning is as dangerous and unpredictable as ever, but much of the death and damage it used to cause is now prevented by knowledge of its behavior.

This "taming" of lightning has come about through better understanding of what lightning really is and how it works.

The old Greeks thought that lightning strokes were flaming spears that their god Zeus hurled down at his enemies from the clouds above. Most of us still think of lightning as "striking" down at a man or building from the sky.

But one of the new things that has been learned about lightning is that it may actually "strike" upward from the ground. This is because lightning is really a high-speed flow of current back and forth between powerful electric charges that have accumulated not only in the thundercloud but in the ground below it.

It is the current flowing up out of the ground that probably does the damage; in other words, that "strikes".

Knowing this fact has not enabled us to control lightning, but it has aided in showing how to avoid lightning's dangers.

Bolts Play Strange Tricks

Lightning plays strange tricks. Once it struck and set fire to a house, then leaped to a nearby fire-alarm box, set it off, and summoned the engines!

A New Jersey farmer sat reading under a lamp in his home. Lightning flashed along the wiring and singed off his hair to within a quarter of an inch of his scalp, but did him no other harm.

Two boys were struck while they slept in a tent beside a lake in Maine. They awoke to find their legs paralyzed from the waist down, their feet, legs, and sides burned, and an ax blade between them melted. Eventually the paralysis in their legs passed away.

In Minneapolis lightning threw a typewriter up from a table and imbedded it in the ceiling. A closet door was torn off and hurled to the porch roof outside. A dresser was shattered, but one drawer remained undamaged and was driven between the springs and mattress of a bed in which two girls were sleeping.

All these and innumerable other antics of lightning can be explained if you remember that lightning is an electric current.[1] At the end of the stroke it always tries to find a path of least resistance. That's why it follows wires, jumps to metal objects, and sometimes goes through people's bodies because they offer less resistance than air, which is not a good conductor.

[1]See "The Fire of Heaven (Electricity)", by Albert W. Atwood, NATIONAL GEOGRAPHIC MAGAZINE, November, 1948.

Odd Facts About Lightning

Here are some other facts about lightning:

Your chance of being killed by lightning in the United States is about one in 365,000.

Lightning can and does strike not only twice but many times in the same place. It has hit the Empire State Building in New York City as many as 12 times in 20 minutes, and as often as 50 times a year.

One of the safest places you can be during a lightning storm is in your car, if it's an all steel closed model, as are most modern ones. If the car is struck, the steel body will conduct the current away from you. Equally safe, but less practical, are the insides of your furnace and mechanical refrigerator, for they're all metal too!

Lightning rods don't keep lightning from striking your house or barn. But if lightning does strike a properly rodded building, the rod system carries the current harmlessly to the ground, without fire or other damage.

If lightning strikes an all-metal airplane, such as those in general use on commercial airlines today, the people inside will not be harmed. There is no known case of lightning directly causing an airplane accident.

Lightning strokes between two clouds actually are far more frequent than between a cloud and the ground. In such a case one cloud carries a negative charge, the other a positive one. Lightning also can occur inside a single cloud, between the negative charge in one part of the cloud and a positive charge in another.

Power enough to supply a large city, hundreds of thousands of amperes, may be contained in a single lightning stroke. The most powerful stroke ever recorded in the United States hit the Cathedral of Learning of the University of Pittsburgh on July 31, 1947. It discharged a current of 345,000 amperes, or enough to light more than 600,000 sixty-watt bulbs for the duration of the flash. This vast power, however, is "turned on" for only about 35 millionths of a second.

ACME

Mains Broke, Gas Burned, and a Car Fell into the Subway When a Bolt Struck in Brooklyn

Gas lines under the street were supported by temporary decking. When lightning smashed the props, pipes collapsed and gas caught fire. Gas in tanks or subsurface mains cannot be exploded by lightning.

Lightning strokes between a cloud and the ground may be three miles long or more. Between two clouds they may flash over a distance up to 10 miles. Lightning travels 20,000 miles a second.

Franklin and His Famous Kite

Ben Franklin. When he flew his famous kite in a thunderstorm in 1752, probably didn't draw actual lightning down his kite string to the key at the lower end. If he had, he might not have lived to tell the tale.

The electric sparks that jumped off the key were most probably produced not by lightning itself but by the discharge of stored-up electricity in the air, a condition that goes with a lightning storm. That detracts in no way from Franklin's fame as the discoverer that lightning is electricity

W. J. Trayte from Colombus Dispatch

A Heavy Bomb Could Scarcely Do More Harm than the Bolt Which Struck Here

Lightning is believed to have penetrated this Columbus, Ohio, bridge and caused an explosion, resulting in the damage. One person was killed; four were hurled into the river.

and that a system of lightning rods will protect buildings from damage.

Lightning is very hot. Some strokes at their peaks generate a temperature as high at 27,000 degrees F.

You've probably tried estimating how far away a lightning flash is by counting the seconds between the flash and the noise of the thunder.

Light from the flash reaches your eye almost instantaneously, but the sound of thunder travels only about 1,100 feet a second. If you count five seconds between flash and thunder, the lightning was about 5,300 feet, or one mile distant.

My grandmother used to say that thunder came when storm clouds were bumping together. Today the scientists know that it really is the noise produced when the lightning current literally explodes apart the atoms and molecules of the air as it smashes through them.

Those ripping, tearing sounds so often heard when a storm is at its height come from the lightning striking the ground near by. The rumbling, booming sound of thunder comes from strokes to the ground at a distance.

Thunder cannot be heard for more than about 18 miles. Sounds of cannon fire carry much farther. Some lightning strokes produce no thunder. They are "slow," lasting 1/10 to 1/20 of a second instead of the usual few millionths. They do not break down the air atoms fast enough to make an explosive noise.

Some people who are struck by lightning die needlessly because others near by are afraid to touch them, believing that their bodies are charged with electricity.

Actually, the lightning current passes instantaneously out of the body of the victim into the ground. If he is not instantly killed, he may be saved by the prompt use of artificial respiration.

High-voltage electric current passing through the body often paralyzes the nerves and muscles controlling the diaphragm, or breathing mechanism. Artificial respiration keeps the victim breathing until this paralysis passes away. Lightning victims also are usually burned, but the burns can be cared for later. First of all, try artificial respiration.

Fertilizer from the Air

Lightning, does some good, too. It manufactures right out of the air, about 100 million tons of valuable nitrogen fertilizer every year. Air consists of roughly four parts nitrogen to one part oxygen. Lightning discharges combine the nitrogen and oxygen with the rain which carries the fixed nitrogen down. Much of it falls into the sea, but enough comes down on land to help at least a little in fertilizing the soil.

Fertilizer manufacturers have used the same method to get nitrogen out of the air, by discharging electric sparks continuously. A far more efficient method than nature's haphazard way.

Over the earth as a whole, it is estimated that there are some 44,000 lightning storms every day, 100 lightning flashes every

ACME

Eight Lightning Rods Guard Washington Monument's Tip

Though the Monument has been struck as many as six times in a single storm, the current flows harmlessly to earth along the rod system connected with the steel elevator shaft. As a precaution the elevator is stopped during electrical storms. These men examine noncorroding platinum points from a scaffold a few feet short of the tower's 555-foot peak.

second. In the United States alone about 400 people are killed annually by lightning, and around 1,500 more injured.[2]

Insurance companies in the United States between 1936 and 1946 paid $54,148,995 in claims for fires caused by lightning.

[2]See "Weather Fights and Works for Man," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE December, 1943.

Nobody knows how much more was lost in unreported and uninsured fires. Lightning stands fourth among the causes of fire-loss claims.

Lightning is the leading cause of fires on farms and in rural areas, and most of the deaths and injuries from lightning occur in the country. That is because the crowded buildings of large cities offer better protection from lightning strikes. They usually also contain water and heating pipes that act like lightning rods to carry current to the ground if a house is struck, resulting in less damage. In cities, too, there's better fire protection.

How Nature Produces Lightning

Just how Nature produces a stroke of lightning is now pretty well understood by scientists, though some of the details are still uncertain. It is a gigantic and awe inspiring process.

A thundercloud takes shape when rising air currents carry moisture far aloft. Raindrops form in the cloud and start to fall. Inside the cloud, turbulent air currents are moving up and down at terrific speed. These currents toss the raindrops about, breaking them up, and somehow in this process a negative electric charge is concentrated in the lower part of the cloud. All this Julius H. Hagenguth of the General Electric Company's High Voltage Engineering Laboratory explained to me.

This charge grows stronger and stronger as the up and down drafts inside the cloud keep ripping and tearing at the raindrops. The negative charge in the cloud attracts to the ground area beneath it an exactly equal positive charge. As the wind blows the thunder cloud along, the charge in the ground follows directly below.

Positive and negative electric charges always attract each other. The charges in the ground and cloud try desperately to come together, but the air between them prevents this at first, because air is not a good conductor of electricity. As the charge in the earth moves along, it swarms up trees, buildings, chimneys, and steeples in its path in an effort to reach the cloud.

Soon the charge in the cloud begins to send down a short spurt or "leader" stroke toward the ground. This shoots down

Westinghouse Electric Corp.

Lightning's Passage Fuses Sand into Hollow Tubes

Known as fulgurites, these samples were made by artificial lightning shot through quartz sand in the Westinghouse High Voltage Laboratory. Fulgurites sometimes are made when lightning surges through dry sand in search for moist earth. Sudden, extreme heat expands gases, fusing the sand.

about 80 feet below the cloud, breaking apart, or "ionizing" the atoms of air in its path. When air atoms are broken apart this way, they suddenly become better conductors of electricity.

Following the path thus made, the leader flashes downward by steps. Meanwhile, the positive electric charge in the ground

is being attracted and concentrated by the downward-flashing leader. Finally, when the leader almost reaches the ground, the ground charge may send up a leader of its own a single or multiple streamer, to connect with the leader coming from the cloud. All this happens in a hundredth of a second, more or less.

Suddenly the leaders from the cloud and ground push down and up far enough to meet. An unbroken pathway of ionized air now extends from cloud to ground. Then, along this path, a terrific flow of current rushes, from ground to cloud. This is the lightning flash you see, and it is probably what does the damage.

This stroke follows a path of ionized air that may be as thin as a hair or about two inches wide. After the main stroke, several other minor ones may rush up and down this path between cloud and ground, but so fast that to the eye they all appear as part of the one big flash.

Lightning's desperate eagerness to flow between cloud and ground explains most of the seemingly freak things that it sometimes does. It is more likely to strike tall objects, such as trees, barns or steeples, because they furnish a shorter path between cloud and ground.

Lightning smashes brick chimneys, furniture, wooden walls, and plaster because such materials offer resistance to its progress. In forcing its way through them it builds up internal pressures that expand outward with explosive force. Trees ripped apart by lightning are literally blasted by gases formed within the wood by the lightning's passage.

Lightning rods of today are not the tall spindles ornamented with glass balls that you sometimes still see on farm buildings. They are short metal spikes, all connected to copper or galvanized-iron cables that lead down the sides of the building and go into the ground deep enough to contact soil that is permanently moist.

If lightning rods are placed on a building that contains other metal, such as a forage or hay-loader trolley in a barn, electric-light wires, plumbing, etc., all these are bonded to the rod system.

Any steel-frame structure, such as a skyscraper, is a lightning rod in itself. A lightning bolt striking it is automatically carried

harmlessly to the ground by the steel. There should be a metal connection between the outside of the roof and the frame, however, so that lightning will not damage the roof in making its way inside to reach the steel.

Rods Protect Even Trees and Monuments

Lightning rods are used to protect historic and valuable trees, and many important monuments are equipped with them, including the Statue of Liberty in New York Harbor and the Washington Monument.

During World War II ammunition factories were specially guarded against lightning. Local Weather Bureau offices kept them informed of the approach of thunderstorms. Patrol cars also often scoured the countryside equipped with radios to warn of storms.

When a storm came close, operations ceased until the danger was past. Even if lightning did not strike the factory, there was danger from the static electricity existing in the atmosphere, which always accompanies a thunderstorm.

"St. Elmo's fire," which sailors used to think was a portent of disaster when they saw its eerie glow on the tips of masts or spars, actually is a warning that conditions are ripe for a lightning stroke.

It shows that electrical charges have built up in the clouds overhead and the ground below, and that the charge in the ground is so strong that some of it is "leaking" off in visible form. The charge flows off most easily from a high, sharp point such as a steeple, mast, or flagpole, but it may appear almost anywhere.

Two boys riding horseback suddenly noticed that each other's heads and the rumps of their horses were outlined by the glow of St. Elmo's fire.

Though harmless, St. Elmo's fire has been regarded with superstitious awe by sailors, as in Coleridge's Rime of the Ancient Mariner:

About, about, in reel and rout
The death-fires danced at night . . .

Others have believed it to be a weather indicator. Longfellow's Golden Legend says:

Last night I saw Saint Elmo's stars,
With their glimmering lanterns, all at play
On the tops of the masts and the tips of the spars,
And I knew we should have foul weather today.

Since a lightning storm is certainly "foul weather," the old belief was not so far wrong!

St. Elmo's fire sometimes is seen on the wing tips and propellers of airplanes, where it is a sign of a special kind of trouble. It means that an electrical charge has built up on the airplane and in flowing off is causing such severe radio static that the pilot cannot communicate with the ground or other planes. Today this is largely overcome by metallized cotton cords that conduct the discharges off into space without causing static.

A Few Rules of Safety

Much of the death and injury from lightning could be avoided if people kept in mind a few rules of safety.

Most important: get indoors, in a house, barn, or whatever building is handy, the bigger the better. Roofs and walls of buildings usually provide an easier path than the human body for lightning to follow to the ground.

When a thunderstorm threatens, keep away from beaches, fields, golf courses, and other open places. Don't go in swimming, for you may be electrocuted by lightning current that has traveled through the water from some distance away. Even if it only stuns you, you may drown. Don't ride a bicycle or horse, or operate an open machine such as a tractor.

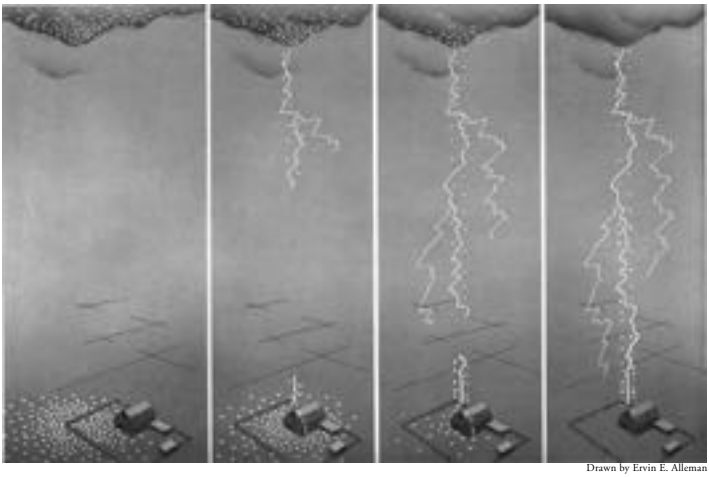
Keep away from exposed hilltops, high masts, and isolated tall trees. A tree or similar object is a triple threat. If the tree is struck, the lightning may jump from it to your body; it may

National Geographic Photographer John E. Fletcher

Lightning Rods Guard 23 Mount Vernon Trees, Including 10 Planted by Washington

Unprotected trees are hazardous refuges in storms; they may be ripped apart when a bolt's passage forms expanding gases within the wood. Anyone caught in the open might better lie on the ground. Here a cable is installed on a 18 year-old pecan to connect rods in the foliage with others buried in the Virginia soil.

enter your body from the ground after striking the tree; or the tree may explode, injuring you by flying fragments. Don't go near wire fences, or other wires. Lightning may travel long distances along barbed-wire fences, far from the place where it originally struck. Livestock often is killed this way.



Drawn by Ervin E. Alleman

How Lightning Strikes: Electric Charges in Earth and Cloud Make Contact, Sending Heavy Current Through the Barn

In a thunderhead a negative charge builds up in the cloud and and a positive charge in the ground (minus and plus signs). Charges attract each other, sending streamers down from the cloud and up from the highest point on the ground. When they meet, a powerful current flows between. This is lightning.

Indoors, the center of the room is about the safest place. Closing the windows will not stop lightning from entering. Since the chimney is usually the highest part of a house, lightning may strike there and follow down into the fireplace or stove; therefore, those are good places to avoid. Wiring systems and water pipes also make good pathways for lightning that strikes a house: so avoid the radio and electric-light switches, keep away from radiators, and don't take a bath or shower.

All telephone lines entering buildings are equipped with lightning arresters, which reduce but do not eliminate the danger of using the phone during a lightning storm. It is better to postpone a call until the storm has passed, especially in rural areas.

If you do get caught away from shelter, out in the open, take refuge in a ditch or cave or under an overhanging cliff, rather than stay in an exposed place. If there is no shelter of any kind, its safer to lie on the ground than to stand up. Getting wet is better than being struck by lightning. Wear-

Westinghouse Electric Corp.

Man-made Lightning Striking a Model Powerline in a Laboratory Shows How Overhead Wires Prevent Damage

Westinghouse engineers use this miniature system for tests. Upper wires detour the three-million-volt stroke harmlessly to the ground. Lower wires, which carry the power load, are thereby protected against lightning, which might shut off the current or damage equipment. Even the cows are man-made.

ing rubbers, incidentally, will not protect you from a lightning strike.

A newspaperman in Ohio who was struck by lightning lived to write about it in his paper. He was standing in a barn door when a bolt knocked him unconscious. When he came to, he first felt that he wanted to die: then this feeling was replaced by a great desire to live. He couldn't move or speak, and felt numb all over. When feeling returned he suffered severe pain, which persisted for a long time in his bones, muscles, and ligaments. He had burns on his face and body. His sports shirt was torn to shreds and the buttons ripped off.

In a national forest in Utah lightning struck in the midst of a herd of sheep and killed 835. The herder was knocked unconscious for two hours. In this case the sheep probably were killed by the stroke traveling from the ground up one leg, through the body, and down another leg. This was because the ground offered more resistance to the passage of the current than the sheep's bodies. Cows often are killed the same way.

U.S. Air Force Official

Though Lightning Strikes Within Inches, Passengers Are Safe in an All-metal Plane

A test at the United States Air Force's All-Weather Flying Center, Wilmington, Ohio, shows how the plane's metal skin sheds current. In the air it might suffer holes burned in wing tips or fuselage, or a radio antenna burned away. Two passengers calmly ignore the man-made bolt.

Little Danger to Airplane Travelers

Lightning is not a serious danger to airplanes, because, if they are struck, the metal skin conducts the current away from the pilots and passengers.

National Geograpic Photographer Willard R. Culver

Lightning Striking a Golf Green's Flagstaff Left Its Imprint on the Grass

Golf courses and other open areas are dangerous during electrical storms. This weird mark was made on the grounds ot the Chevy Chase Club near Washington, D. C.

Daring pilots participating in the "thunder storm project" operated by the U.S. Weather Bureau. Navy, and Air Force flew planes 1,363 times into the centers of thunderstorms to see what would happen. The planes were struck by lightning 20 different times, but the only damage was radio antennas burned off, small holes up to dime size drilled in wing tips, rudders, and elevators, and the head of one airspeed indicator slightly bent.

One pilot flying through a thunderstorm at 26,000 feet in heavy snow reported: "Radio static kept building in intensity until it was so severe that I couldn't keep the earphones close to my ears. I heard what sounded like the sharp burst of a German 88-mm gun. A sheet of flame simultaneously enveloped the entire cockpit. My airspeed indicator jumped from 190 to 500 miles per hour and stayed there.

"Everything looked a bit fuzzy. The air was so turbulent and the instruments jumped around so much that I couldn't tell for a moment what was going on. I just let the airplane buck through. Then after what seemed hours the airspeed came back to normal."

ACME

Forked Lightning, the Storm God's Grasping Fingers, Seems to Reach for Prey

Lightning bolts from the sky branch out in this fashion as they grope for currents rising from the ground. Strokes from cloud to ground may be three miles long. Those from cloud to cloud 10 miles. This spectacular night display illuminates Milwaulkee, Wisconsin.

Film records showed that his airspeed indicator actually stayed at the erroneous reading of 500 miles per hour for only about 80 seconds. The radar operator in the same plane, who was not wearing dark goggles, said he was unable to read his indicator panel for about two minutes after the flash.

Western Electric Corp.

Lightning Cannot Harm the Driver Who Stays Inside His Steel Fort

A three-million-volt stroke strikes harmlessly in this test at Westinghouse's High Voltage Laboratory. Metal carries the current to the front wheel, where it leaps across rubber to ground.

Dr. Ross Gunn of the Weather Bureau made 25 flights through thunderstorms, and his plane was struck three times. He heard only sharp clicks when the lightning hit, once within a foot of him. No one felt anything.

Pilots avoid thunderstorms, not because of lightning, but because of the far greater danger from the turbulent air currents inside the cloud. Such currents can dash a plane thousands of feet upward or downward in seconds. They have thrown B-29s on their backs.

To the U.S. forest fire lookouts[3] who guard the national forests in the inaccessible mountains of the Pacific Northwest, lightning is a dreaded enemy. It starts about 6,000 forest fires in this country every year.

[3]See "Forest Lookout." by Ella E. Clark. National Geographic Magazine, July, 1948.

Hans Groenhoff

A Sailplane Pilot Sets Out to Ride a Turbulent, Drafty Elevator into the Sky

A few glider men venturing into true thunderheads have been driven upward a mile a minute and tossed like feathers. This cumulus congestus cloud promises updrafts but no lightning. The plane Screamin' Wiener, takes a tow near Elmira, New York. In Texas it set an international goal-and-return record of 229 miles.

In the East, where rain more often accompanies or follows a storm, lightning causes only about 10 percent of the forest fires. But in the Northwest it starts three-fourths of all the fires, a far greater menace than careless campers.

In the central Sierra Nevada forests, one year, lightning started 100 fires every day for seven days.

General Electric Company

Lightning, Quicker than the Eye, Is Analyzed by the Camera. Eleven Strokes Appear as One

A central lens photographs what the eye sees, A "single" bolt to New York's Empire State Building. A second lens slowly rotating around the other records the 11 (numbered) flashes which actually sped between cloud and tower. Scientists put such seemingly unimportant facts to work protecting electrical equipment.

LOOKOUTS GUARD AGAINST FOREST FIRES

All during the summer thunderstorm season, fire lookouts anxiously scan the horizon for thunderheads. When the light-

Betmann Archive

Ben Franklin's Kite String Was More Dangerous that He Knew

Sparks that jumped off his famous key were only atmospheric eletricity, scientists believe. True lightning probably would have killed him. Franklin actually flew his kite from a doorway that kept him dry, together with the end of his kite string. In the open, the risk would have been much greater.

ning begins to flash, they try to spot the directions of the places where they can see it strike. These places may need watching for days, for a lightning fire may smolder for a week in the dry duff of the forest floor before giving out a telltale column of smoke.

W.E. Steurwald from U.S. Forest Service

With a Lightning Protector, These Wires Will Meet Emergencies

Lightning has been known to vaporize hundreds of feet of telephone wire, leaving empty insulation. Bolts start three-fourths of the forest fires in our Northwest. This engineer checks a lightning device in Lolo National Forest, Montana. Without it, the line might be knocked out, delaying fire fighters.

Fire lookouts in their exposed mountaintop stations sometimes have been struck and killed by lightning, but today the lookout's shack is the safest place on the mountain. The metal roof is bonded to heavy cables that run down the corners and out in deep trenches to a buried wire net or bed of salt. All

ACME

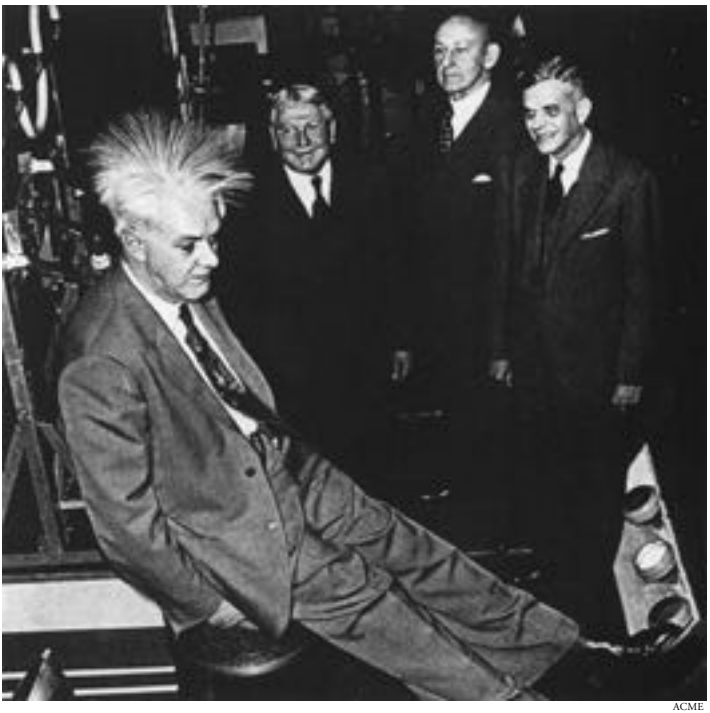
Lightning Gouged This 40-foot Trench

Three baseball players were killed when a bolt burrowed the infield during a game at Baker, Florida, in 1919. Fifty persons were injured. Ground's resistance to current "blew" the earth like a fuse.

metal objects, such as the stove and bed, are connected to the cable. The lockout avoids using his telephone while the storm is raging.

On one mountain in Idaho, appropriately named Heavens Gate, blue flames often play around the telephone circuit grounding wire during a lightning storm. Lightning running along forest telephone lines has been known to vaporize hundreds of feet of wire, leaving nothing but empty insulation strung beside the trail.

If the lightning starts a fire, the lookout calls for the airborne fire fighters, who drop by parachute or land via helicopter close to the fire. Sometimes even then they're baffled, for the



ACME

Lightning in the Offing Could Give a Man a Porcupine Hair-do

Richard Hitchcock, Westinghouse Electric Corporation research engineer, sits on a static oenerator and demonstrates its effect to members of the Chicago Association of Trade. Static electricity in a comb produces a related but milder spectacle. Just betore a lightning stroke, the air becomes so charred that its electric content could raise the hair on a man on top of a tall building.

fire may be smoldering in a hollow or rotten treetop, invisible to men on the ground under the thick trees.

Lightning can be a menace to the fire fighters too. One man stopped to rest with a foot on the blade of his shovel stuck in the wet ground. Lightning hit a nearby tree, jumped to the shovel, and knocked the man unconscious.

Since scientists can't stop lightning from striking valuable timberlands, they now are planning a new attack, against the source of the lightning. They plan to try dissipating thunderclouds with dry ice before the lightning ever gets started.

U.S. Forest Service officials, at the suggestion of Dr. Vincent J. Schaefer of the General Electric Research Laboratory, plan to drop dry ice from airplanes flying over the tops of upsurging thunderheads.

Dr. Schaefer says it is believed that thunderclouds would not accumulate the electric charges that produce lightning if the water droplets in them were not considerably "super cooled." He thinks that if a large degree of supercooling can be prevented by changing the water droplets to ice crystals, the cloud ceases to be a lightning factory, and lightning will not occur.

This can be brought about, he thinks, by "seeding" the cloud with small quantities of dry ice, the same method that he and Dr. Irving Langmuir discovered to produce snow and rain from clouds that otherwise refused to give up their moisture.

Most of our modern knowledge of lightning comes from research done by the big manufacturers of electrical equipment, such as General Electric and Westinghouse Electric Corporation. Lightning has been one of their big headaches.

Protection for Power Lines

In today's electrical age, the countryside is crisscrossed with electric power transmission lines, favorite targets of lightning strikes. Every mile of transmission line in some parts of the United States is struck by lightning on an average of once a year.

Lightning striking an unprotected transmission line may cause an interruption in the flow of electricity that can deprive a whole city of light and power for hours. A delicate surgical operation, on which a man's life depends, may be interrupted at the crucial moment. Electric refrigerators, clocks, elevators, factory motors, and innumerable other kinds of electrically powered equipment may fail, with potentially disastrous results.

Before lightning protection devices were in general use, some power lines had as many as 100 interruptions to service in a single year.

Lightning can interfere with a city's electric power in two ways. After striking a power line, it may travel along the wires

National Geographic Photographer Robert F. Sisson

Man's Mightiest Bolt Leaps 50 Feet with Thunderous Roar

Most powerful artificial lightning ever created flashes between two generators in the General Electric Company's High Voltage Laboratory at Pittsfield, Massachusetts, with a peak energy of 15 million volts.

Scientists make lightning on the same principal as Nature. A positive charge is built up in one generator (lower left) and a negative in the other (extreme right). These charges attract each other. When they become strong enough, the current leaps between them.

In the same way Nature's lightning jumps between negative charge in a storm cloud and positive charge in the earth, but over a wider distance.

Branches forking out from the main stroke show where currents from the two generators try to come together by various routes. A similar phenomenon occurs in natural lightning.

Man-made lightning is as powerful as the real thing, but the strokes are shorter. Scientists use it to learn how Nature's lightning behaves. They employ this knowledge to protect power lines and equipment.

and do serious damage to transformers, generators, motors, and other equipment. Or it may jump from the power line across an insulator to the steel tower and go to the ground. The regular power "juice" may follow the lightning current, leaking off into the ground instead of flowing along the line. The effect is the same as a heavy leak in a water pipe.

To avoid this, lightning arresters are installed. They operate like safety valves on boilers, which stay closed until dangerous

steam pressure builds up. The arresters are connected between the power line and ground. The normal amount of voltage, or electrical pressure, on the line cannot open the "safety valve" to get to the ground.

But if lightning strikes the line, the voltage is vastly increased. This opens the valve, and the lightning current is carried off to the ground without further damage to the line. At the same time the arrester keeps the regular power current from following the lightning current to the ground.

Many power lines are protected by a special "ground" wire or wires strung along the lines some distance above the wires that carry the power. These upper wires are grounded — that is, connected to the ground — at frequent intervals, and act as horizontal lightning rods. Lightning is more likely to strike them first, and is carried off to the ground without doing damage.

Sometimes lightning may jump from the ground line to the power line. Then circuit breakers come into action and disconnect the line from the power source. After a fraction of a second, they are closed again, and power flow resumes. It all happens so fast that there is only a flicker of the lights and no noticeable interruption in the use of power equipment.

But if lightning strikes the line the flow of current is vastly increased. This opens the "valve" and the lightning current is carried off to the ground without further damage to the line. At the same time, the arrester keeps the regular power current from following the lightning to the ground.

"Man-made" Lightning Produced

Most of what is known today about lightning has come from experiments both with the real thing and with "man-made" lightning, which can be controlled and made to strike when and where desired.

Lightning strikes so often on the top of the Empire State Building in New York City that General Electric Company engineers set up instruments there every summer, knowing they can depend on having many strokes to aid their experiments. High-speed cameras and oscillographs are turned on by the light-

ning itself and automatically photograph the strokes and record the rise and fall of current during a flash.

General Electric's new High Voltage Laboratory at Pittsfield, Massachusetts, uses artificial lightning strokes up to 50 feet long, with a power of 15 million volts, for research.

This man-made lightning is produced in essentially the same way that Nature does it, but two big electrical generators take the place of the thundercloud and ground.

With such man-made lightning engineers can reproduce all the effects of natural lightning on a power line, although not to full scale. They even have made a portable lightning generator that they took out into the country and used to hurl lightning at real power lines to see what happened.

As a result of all this experimenting, lightning nowadays seldom causes serious trouble for electric power companies.

Lightning has been classified into various types, though all really are essentially the same. Streak lightning is the kind that is most often seen.

Sheet lightning is a discharge over a wide area, usually between clouds in the upper and lower parts of the atmosphere.

Heat lightning is ordinary lightning, seen from too far away to hear the thunder that goes with it. Ribbon, beaded, and forked lightning are probably the same as streak lightning.

Many people have reported seeing "ball lightning," usually in the form of a luminous ball that rolls around inside a room or perhaps outside in the yard. Usually disappearing after a few seconds with a loud report. Opinions differ on this, but some scientists think it is really just an "afterimage" retained for several seconds by the eye after seeing a brilliant flash of regular lightning. The loud report accompanying the disappearance of the "ball" could be just another thunderclap.

Lightning can occur in connection with tornadoes, volcanoes, dust storms, and snow storms, or even as a "bolt from the blue" on days that apparently are cloudless.

A good thing to remember about lightning is an axiom stated by Dr. Karl B. McEachron of General Electric:

"If you heard the thunder, the lightning did not strike you. If you saw the lightning, it missed you. And if it did strike you, you would not have known it!"

THE EVENT

PETRIFIED LIGHTNING FROM CENTRAL FLORIDA

A PROJECT BY ALLAN MCCOLLUM

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