

## METEOROLOGY

# Speed of Lightning Revealed By Unique Camera Set-Up

## Main Discharge Travels Upward From Ground Following Path Established by Faint Downward Leader Stroke

**H**OW FAST does a thunderbolt travel? This question has been answered by Dr. B. F. J. Shonland of the Cape Town University, and H. Collins of the Victoria Falls and Transvaal Power Company.

Using a camera provided with two lenses revolving in a circle at opposite ends of a diameter, an arrangement described by C. V. Boys in 1926, the two experimenters photographed a number of lightning strokes between earth and cloud. A moving lens tilts the image of a lightning flash on the plate much as a focal plane shutter causes a swiftly moving automobile to seem to lean forward. The other lens, moving in the opposite direction, tilts the image the other way, so that the real angle of tilt is found as half the angle between the two images. Knowing the speed of the lenses, which made 1500 revolutions per minute, the experimenters could find not only the duration of the discharge, but which way it was going and how fast. They could determine also how long the luminosity persisted after the discharge had ceased, and other details.

Almost always, they found, the main flash was preceded by a faint "leader," as they call it. This traveled downward from the negatively charged cloud to the positively charged earth. As soon as it struck the earth, the main flash started upward from the same spot, and followed exactly the same path that the leader had taken, to the cloud.

The leaders were invariably thin, of uniform width, and unbranched. Their speeds ranged from 810 to 19,900 miles per second. They averaged 5,150 miles. The length of the strokes observed varied from 1.6 to 4.7 miles. The longest time occupied by a leader stroke was 1670 micro-seconds for a 4.7 mile stroke. The quickest flash took 69 micro-seconds to travel 3.5 miles. A micro-second is one millionth of a second.

The lengths of the strokes were measured along the crinkly paths registered on the plates. These did not show, of course, the motion toward or away from the camera, and the experimenters es-

timated that the real lengths of the strokes in space, and consequently the real velocities, were about 30 per cent. higher than those measured.

The leader appeared to be composed of an elongated dart. From the width of the track on the plate, the investigators were able to determine the duration of the luminosity at any point, and assuming that this was the time required for the dart to pass the point, they were able to measure the lengths of the darts. These varied from 80 to 370 feet, the average being 180 feet.

In conformity with the theory proposed by Dr. N. Ernest Dorsey in 1926, the authors believe that the leader consists of an "electron avalanche," which goes ahead and ionizes the air, thus preparing a conducting path for the main discharge that follows.

The main discharge is entirely different in character. It is thicker and brighter, and the thickness diminishes upward. It is more like a soaring flame than a moving dart. Also it travels faster. The speeds ranged from 14,900 to 68,400 miles per second, the average being 28,500 or about 15 per cent. of the speed of light.

Often the main upward discharges

were branched—but they branched downwards. After each branch the main stem thinned but did not pause in its upward motion. The branch occurred at or after the moment the head of the discharge passed the point. The branches did not always occur in regular sequence, a lower branch sometimes sprouting out after an upper branch had developed.

The time required for the discharge to reach the cloud varied from 44 to 65 micro-seconds. To reach the end of the last branch took from 40 to 145 micro-seconds. The bright luminosity at the base lasted from 12 to 164 micro-seconds. Usually it was out before the discharge reached the cloud, occasionally not. A faint luminosity, however, lasted much longer, sometimes as much as a fiftieth of a second, as though the path had been heated and continued to glow.

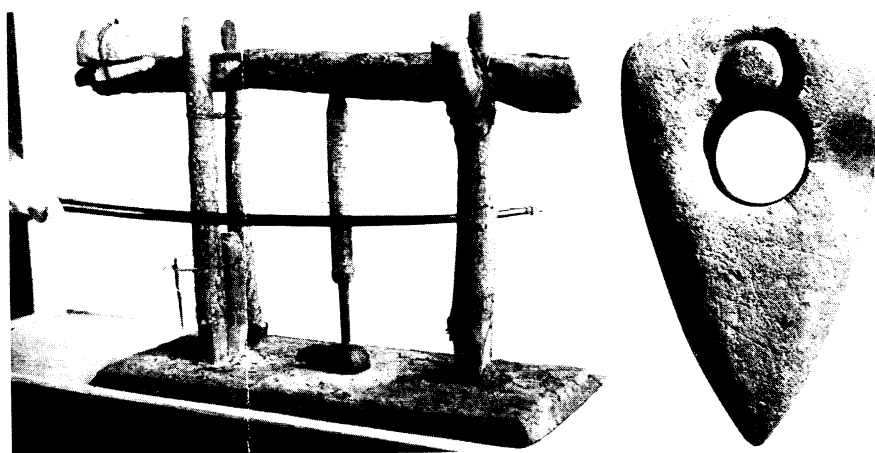
The experiments were made for the Lightning Investigation Committee of the South African Institute of Electrical Engineers, and are to be continued.

*Science News Letter, March 17, 1934*

## ARCHAEOLOGY

## Man a Machinist For 10,000 Years

**B**ENJAMIN Franklin is credited with having originated the definition of man as a tool-making animal. But even the immortal Benjamin and all the eighteenth-century natural philosophers who were his peers might well have been astonished at the prehistoric extension which has been given to man's activities not merely at making tools but at making machinery for the mak-



NEW STONE AGE DRILL-PRESS AND DRILL-HOLES

*Die Umschau*

*The drill-press was reconstructed by Prof. Wolfgang La Baume, of Danzig; the ax-head is an actual Neolithic specimen, with a badly-placed hole that was discontinued before it was completed, and a correctly-placed hole that was bored clean through. The core projecting in the first hole shows that a hollow tool—presumably a bone—was used.*