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PAPERS ON TORNADOES.

THE THIRTEEN TORNADOES OF MARCH 28, 1920.

INTRODUCTORY NOTE.

On the afternoon of March 28, 1920, at least 13 tornadoes occurred, 11 in Illinois, Wisconsin, Indiana, and Michigan, and two or more in Alabama and Georgia. All but one of the northern group occurred along a line of wind convergence between warm southeasterly and southwesterly winds, which progressed from eastern Iowa to eastern Michigan between 6 a. m. and 9 p. m. A similar condition, though less strongly marked, on the southern end of the line produced those in Alabama and Georgia. This line of wind convergence appears to have been associated with a cold wind from the west aloft. The running of such a current over the warm southerly wind readily contributed to the formation of tornadoes. The following papers present the information concerning the destruction, the paths of the storms, the conditions at the surface and aloft. These storms killed 163 people, injured several hundred, and destroyed property valued at probably \$10,000,000.—EDITOR.

TORNADOES OF MARCH 28, IN NORTHEASTERN ILLINOIS.

By CHARLES L. MITCHELL, Meteorologist.

[Weather Bureau, Chicago, Ill., Apr. 28, 1920.]

Three distinct tornadoes occurred in northeastern Illinois between noon and 1 p. m. (Central Standard Time) on Sunday, March 28, and there is some evidence of still another of very limited extent. There were 28 known deaths, 300 persons were injured, and the property losses amounted to over \$3,000,000.

The three in the order of their distance from the main storm center are called (1) the Elgin tornado, (2) the Melrose Park-Wilmette tornado, and (3) the Clearing tornado. The first crossed the extreme northwestern portion of Cook County, the second went all the way across, and the third occurred entirely within that county; moreover, the paths of both the Melrose Park-Wilmette and the Clearing tornadoes lie partly within the limits of the city of Chicago. (See fig. 1.) Previously, so far as known, but two tornadoes ever occurred in Cook County and only one of these, that of May 25, 1896, entered Chicago.

The weather map on the morning of the 28th showed extremely favorable conditions for the development of destructive local storms in Illinois and adjacent States. The center of a severe and widespread disturbance had moved northeastward, with gradually increasing intensity, from Colorado to northwestern Iowa with a central sea-level pressure of 28.96 inches at Sioux City. Thunderstorms were general from the middle and lower Missouri valley eastward to Lake Michigan and Indiana, and the temperature was from 20° to 25° F. above normal, accompanied by rather high humidity, over a large area. By noon the storm was central in southeastern Minnesota and the temperature at Chicago was 60°, with a relative humidity of 84 per cent. The tornadoes occurred in the southeastern quadrant of the storm, about 400 to 450 miles from its center. The minimum sea-level pressure at the Chicago station, about 12 miles from the path of the Melrose Park-Wilmette tornado, was 29.10 inches at about 12:55 p. m., while at the home of the writer,

situated about 5 miles from the path, it fell suddenly 0.15 inch to 29.03 inches, then rose abruptly 0.10 inch.

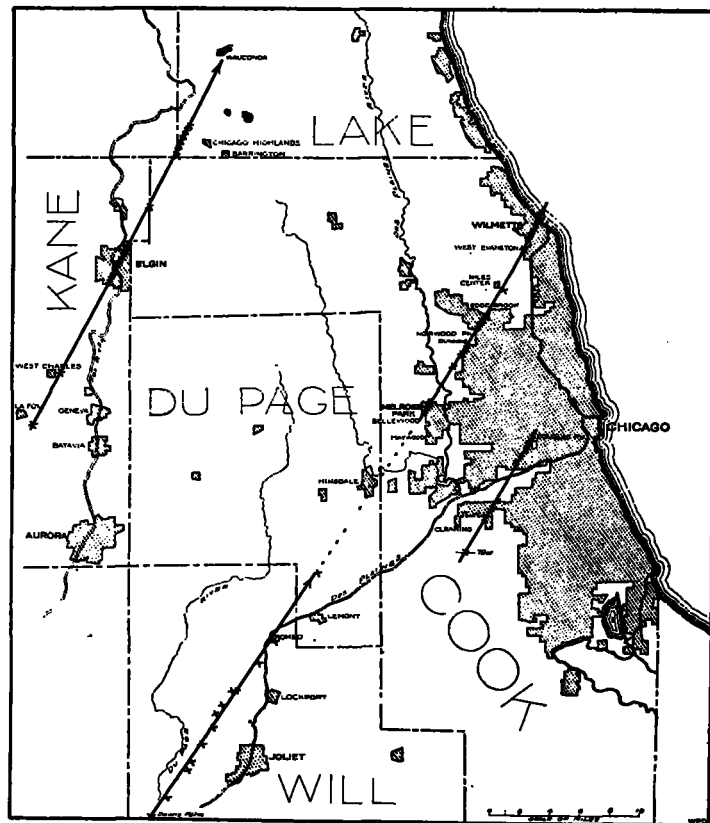


FIG. 1.—Paths of the tornadoes near or in Chicago, Ill., March 28, 1920. Cross-marks indicate points where damage was observed or reported.

The following maximum wind velocities which were registered during the day show how widespread and

severe the storm was. Chicago, 43; Minneapolis, Minn., St. Joseph and Springfield, Mo., 44; Green Bay, Wis., and Concordia, Kans., 46; Duluth, Minn., Keokuk, Iowa, Cairo, Ill., and Evansville, Ind., 48; Wichita, Kans., Kansas City, Mo., Sioux City, Ia., and Grand Haven, Mich., 52; Omaha, Nebr., and Indianapolis, Ind., 56; and St. Louis, Mo., 68 miles an hour. At Chicago the 24-hour wind movement, midnight to midnight, was 604 miles, and from noon to 2 p. m. it averaged 32 miles an hour. The strong wind, which was from the southwest at the lower cloud level, carried the tornado clouds along, practically without deviation, in a northeasterly direction. It is interesting to note that the path of the Melrose Park-Wilmette tornado, which is 50 miles in length, shows a slight curvature, due, probably, to some extent at least, to the gyratory motion of the air around the storm center.

The Elgin tornado apparently had its inception in Kane County about $3\frac{1}{2}$ miles southwest of Geneva and $1\frac{1}{2}$ miles southeast of the village of Lafox at about 12:05 p. m. It moved directly northeastward to Elgin, where it passed through the business center of the city and out Dundee Avenue and the Dundee road. It then moved across the extreme northwestern part of Cook County into Lake County, continuing due northeast to the village of Wauconda, beyond which no reports of damage have been received. The tornado passed one-half mile east of the St. Charles School for Boys at 12:10 p. m., and reached Elgin, 15 miles from its point of inception at 12:23 p. m., or at an average velocity of translation of 50 miles an hour. The total length of its path was approximately 30 miles and its width varied from 300 yards to about one-half mile. Eyewitnesses at various points along its path report seeing a funnel-shaped cloud, but no one in the city of Elgin claims to have seen such a cloud.

Before reaching Elgin the tornado destroyed a farm cottage and several barns and killed four cows. Near the southern limits of Elgin a 4-months' old baby who was being held on its father's lap was hurled through a window of the house and was practically unhurt, but the father was killed instantly when the house collapsed. Only minor damage was then done until after the tornado crossed the Fox River into the business section of the city, where the greatest destruction was wrought. Six business houses were demolished, numerous others were more or less damaged, and three churches were partially wrecked. An actor and his wife were killed when the rear of the Grand Theater caved in, three women were killed as the Congregational Church tower (brick) fell down into the main auditorium, and one woman was crushed to death in the Baptist Church when a part of the front of the brick building fell inward and down through the balcony to the main floor. That there was not much greater loss of life in these two churches was due to the fact that services had been dismissed just a few minutes before the storm broke and most of the congregations had left for their homes.

Leaving the downtown district, the tornado followed Dundee Avenue, which runs southwest-northeast, demolishing about 25 residences, damaging almost 200 more, and uprooting or breaking off scores of trees. At the observatory of the Elgin National Watch Co., 1 mile east of the path of the tornado, the barograph showed a reading of 28.40 inches (about 29.10 inches sea-level pressure) with a sudden decrease of only 0.08 inch.* The wind, which had been blowing steadily from the southeast

at the rate of about 20 miles an hour, suddenly shifted to the southwest at 12.23 p. m., and a maximum velocity of 30 miles an hour was registered with an extreme velocity of 44 miles an hour. The Elgin Daily News describes the tornado as follows:

A violent hailstorm preceded the blast, followed almost immediately by high winds, increasing in velocity. Sudden darkness, a roar, and an atmosphere of flying debris foretold the possible extent of destruction.

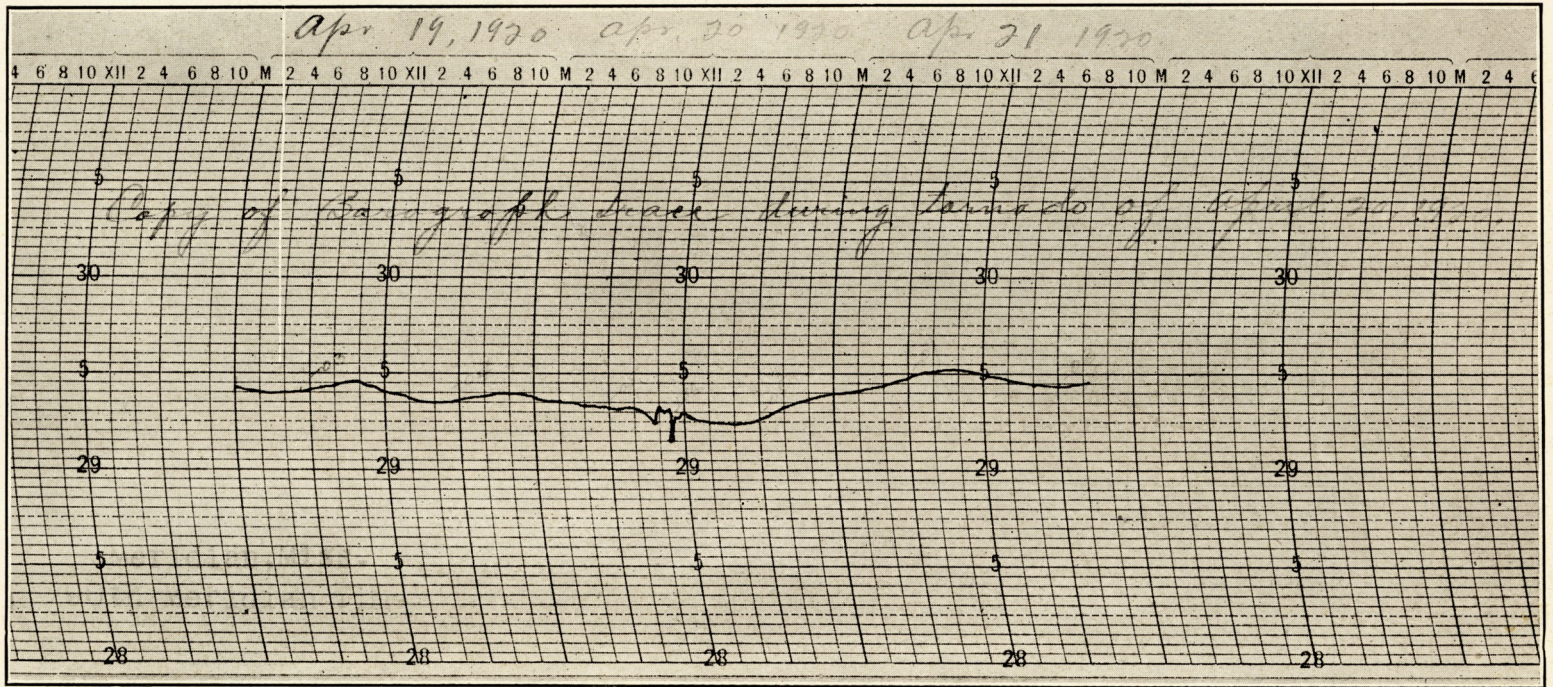
Immediately northeast of Elgin, on the Dundee road, many trees were uprooted or broken off and were left lying to the northeast, north, or northwest. Farther to the northeast the funnel-shaped cloud apparently lifted, descending only at intervals thereafter. The barns at the Bosworth and Logelfarms, 3 and $4\frac{1}{4}$ miles, respectively, from Elgin, were totally destroyed; 10 cattle were killed at the former and 28 at the latter place. About 10 to 12 miles northeast of Elgin and about 4 miles west of Barrington considerable damage was done to farm buildings. The postmaster at the village of Wauconda reports that a funnel-shaped cloud was seen there. The damage sustained in Wauconda and vicinity was about \$30,000, several cattle being killed and many buildings demolished. The Elgin tornado, in its entire path of 30 miles, caused the death of 8 persons, injured about 100 others, and destroyed at least \$1,000,000 worth of property.

The Melrose Park-Wilmette tornado originated about 12.15 p. m. in Will County, $1\frac{1}{2}$ miles north of the village of Channahon and 8 miles southwest of Joliet. The funnel-shaped tornado cloud was first seen and damage was first noted at the farm of John Dixon, near the Illinois and Michigan Canal, where the barn was wrecked, the roof being carried 500 feet. Immediately to the northeast, at a gravel pit, a 90-foot chimney was razed and many large oak trees were uprooted, all falling in a northeasterly direction. The tornado, with its funnel-shaped cloud, rising and dipping at intervals, moved rapidly northeastward across Channahon, Troy, and Lockport townships, injuring 17 people, some of them seriously, demolishing 5 houses, 2 frame school buildings, at least a dozen barns, and damaging several other houses and barns, with a total monetary loss of about \$500,000.

The greatest destruction was wrought about 3 miles west and northwest of Joliet in the vicinity of the Black road and Six Corners. It was here that the 17 persons were injured when their homes were totally wrecked, and most of the farm buildings were demolished in a half-mile path. The tornado was especially violent at the Frank Siegel farm. The house was totally destroyed, the debris being scattered to the southeast and south for a distance of 25 to 75 feet. The family, consisting of father, mother, nine children, and a relative, saw the tornado approaching and endeavored to get to the cellar through the kitchen. However, the house was torn asunder before they reached the cellar stairs, and all, accompanied by a heavy range and the kitchen furniture, were carried 125 feet to the northeast and deposited near a large corn crib which, although directly in the storm's path, was practically undamaged. All members of the family were injured, several seriously.

The tornado cloud lifted when about $2\frac{1}{2}$ miles northwest of Lockport and it dipped only occasionally as it neared the Des Plaines River and the damage was slight in the Romeo section. After leaving the river, the funnel-shaped cloud was not seen and only minor damage was done until the tornado reached Bellwood and Maywood, about 5 miles west of the western limits of Chicago. In Bellwood and Maywood, which join Melrose Park on

* Compare J. H. J. fig. 2, opposite.



J. H. J. FIG. 2.—Barograph trace during the tornado of April 20, at Meridian, Miss. (Tornado passed about a mile from the station.) (See p. 203.)



FIG. 2.—House of Augusta Kruse, Melrose Park, Ill. (Courtesy of Mr. Jun Fujita, Chicago Evening Post.)



FIG. 3.—Ruins of the Sacred Heart Convent, looking northeast across Fourteenth Avenue, Melrose Park, Ill. (Courtesy of Mr. Jun Fujita, Chicago Evening Post.)

the south, 4 lives were lost, 3 persons were injured and about 20 houses were demolished.

The greatest devastation and loss of life was experienced in Melrose Park, where 10 people were killed, 49 injured, about 50 houses, 1 church, and 1 convent demolished, a large brick school building badly wrecked, and numerous houses were more or less damaged. Entering the village in the vicinity of Lake and Twenty-first Streets at about 12:55 p.m., the tornado cut a path northeastward about 100 yards wide, leaving the northern limits at Division and Thirteenth Streets. The Sacred Heart Church was demolished, the church bell, weighing a ton, was carried 100 feet away, and the convent attached to the church was reduced to a mass of ruins. (See figs. 2 and 3.)

The tornado continued to move directly northeastward to Lake Michigan, a distance of about 17 miles from the southern limits of Melrose Park, passing through Leyden township, Dunning, Norwood Park, the extreme northwestern part of Chicago, Niles township, northwestern Evanston,* and across Wilmette to the Lake, which it reached about 1:15 p.m. Much of this region, outside of Wilmette and Evanston, is open country, where the damage was not so great. However, 6 people were killed in Dunning and about 18 were injured in Wilmette. In the latter town the path of the tornado was about two blocks wide. Two churches and many houses were damaged and scores of trees were uprooted. Only a few persons between Melrose Park and Wilmette reported seeing the funnel-shaped cloud. In one hour the tornado moved from its point of inception in Will County to Lake Michigan at Wilmette, a distance of 50 miles. The statistics for the entire 50-mile path are as follows: Lives lost, 20; number injured, about 300; houses demolished, 113; houses partially wrecked, nearly 300; loss to buildings and personal property, at least \$2,000,000.

The path of the Clearing tornado was 10 miles in length, the first damage reported being at West Seventy-ninth Street and Harlem Avenue, at about 1 p.m., and the last on Lexington Avenue just west of South Francisco Avenue, less than 4 miles west-southwest of the Loop District of Chicago, at 1:15 p.m., or slightly later. In the main the damage was confined to unroofed houses, toppled chimneys and broken windows in a path about 100 yards wide. However, in the Clearing section five houses in a row were wrecked on South McVicker Avenue, near West Sixty-first Street, and a home and a portable school building near West Fifty-fifth Street and South Central Avenue were demolished. A funnel-shaped cloud was seen here, but at no other place along the tornado's path. An eyewitness of the approaching storm at West Twenty-sixth Street and South Avers Avenue describes the clouds as being black, low, very turbulent, and rolling. No lives were lost in this tornado, but 6 people were slightly injured, 7 houses and 1 school building were wrecked, and there was a property loss of about \$150,000.

In addition to the three tornadoes described in detail, the cooperative observer at Sycamore, DeKalb County, about 15 miles west of the path of the Elgin tornado, writes as follows:

We had a tornado on Sunday, March 28. A hailstorm that was very bad set in after the tornado. There were several barns, silos, and windmills blown down and telegraph and telephone lines are down. The rural districts east of town suffered the most, the amount of damage sustained being about \$25,000. A funnel-shaped cloud was seen and the path of destruction was about 300 feet wide.

* One peculiar freak of tornado action was the tearing apart of an automobile engine (cf. photo in "Illustrated World," June, 1920, p. 638).—E.D.

This may have been the same storm that passed into Walworth County, Wisconsin.

IN WISCONSIN.

Walworth County.—During the severe windstorm of March 28, 1920, at about 12:30 p. m., a small tornado passed from south to north through the eastern part of Walworth County, Wis. It passed about 4 miles east of Elkhorn, 2½ miles west of Spring Prairie, and 2 miles west of East Troy, where apparently it disappeared.

A funnel-shaped cloud and other tornado characteristics are said to have accompanied the storm. The path of greatest destruction was variously reported as from 20 to 40 rods wide. It evidently was short, as careful inquiry fails to discover it in any other section. There appears to be an opinion that it came north from Elgin, Ill., but I can find no trace of tornado characteristics along the Wisconsin-Illinois boundary. A map showing the probable path is attached. (See fig. 4.)

One woman was killed. Also, several head of live stock were killed, and several barns and many outbuildings and fences were destroyed. The property loss has been estimated at \$25,000.—W. P. Stewart, Milwaukee.

IN INDIANA.

Allen County.—The weather at Fort Wayne, Ind., did not differ materially from the conditions that usually attend a distribution of pressure such as that which existed on the morning and night of March 28. It was rather pleasant during the midday hours, but thunderstorms, attended by light showers, occurred between the hours of 9:35 a. m. and 9:45 a. m. and between 4:58 p. m. and 5:50 p. m. The weather was unusually threatening from 5 p. m. to 6 p. m., and nimbus clouds moving rapidly from the southwest hung quite low. Moderate south to southwest winds prevailed during the afternoon and night, with greatest velocity, 38 miles, from the south, at 4:11 p. m. The lowest sea-level pressure, 29.17 inches, occurred at 5:15 p. m.

In the eastern part of Allen County, Ind., the weather became decidedly threatening the evening of the 28th, and a destructive storm entered the county from the southwest, passing between Hoagland and Monroeville and moving in an irregular path to the northeast. It passed out of the county and State at Edgerton, Ind., 19 miles to the eastward of Fort Wayne, leaving a trail of death and destruction. The storm is reported to have entered Allen County about 5:30 p. m. and to have passed out of the county at Edgerton at 6 p. m. It is said to have had a funnel-shaped cloud and rotary winds, and the position of fallen trees and timbers blown from demolished buildings attest to the truth of these reports. The path of the storm was about a half a mile to a mile wide, but it covered a sparsely settled area, Edgerton, with a population of about 200, being the most populous place in the storm's path. The farming element suffered the greatest loss in the way of damaged or demolished houses, barns, outhouses, and fences. The hamlet of Townley, which consisted of several houses, a store, a church, and an elevator, was completely wiped out and the timbers of the destroyed buildings were scattered over the adjacent fields. The town of Edgerton was badly damaged, but no lives were lost in that place. The fields along the storm's path were literally covered with timbers from demolished structures. Trees were uprooted or twisted off and lay in all directions. In all there were probably 100 houses, barns, or

outhouses either badly damaged or wiped out, entailing a loss estimated at about \$1,000,000. There were 13 lives lost and 34 persons injured.—*P. McDonough, Fort Wayne, Ind.*

Jay and Adams Counties.—The tornado which swept over a part of Jay and Adams Counties—one of three* such storms occurring in northeastern Indiana in the late afternoon of March 28, 1920—first touched the surface southwest of West Liberty, a small village in northeastern Jay County, and is reported to have continued in unbroken contact with the earth for a distance of about 40 miles, passing into Ohio east of Berne, Ind. Considerable loss of life occurred, many were severely injured, and nearly all improvements in the path of the storm were destroyed. The time of occurrence of this particular tornado, shortly after 6 p. m., was somewhat later than the other Indiana storms of this date, and consequently the loss of life was greater, for it was becoming dark, partly due to dense clouds, when the storm struck and many people not realizing that a tornado was approaching took no precautions. Fortunately, the course through Indiana was confined to a strictly rural section, there being only one small village, that of West Liberty, in its path.

The path of devastation east of Berne which was visited by the writer appeared to vary considerably in width, although it was difficult to judge owing to the distance between the houses laterally. At one point two sets of buildings at right angles to the path about $\frac{1}{4}$ of a mile apart were almost entirely destroyed, while the width of partial damage at this place was nearly a mile wide, but at another place a few miles away buildings less than $\frac{1}{4}$ of a mile from the center of action were undisturbed. A majority of the buildings in this district within the sweep of the storm were totally wrecked, and in many cases they were broken into kindling wood and scattered over the near-by countryside. As a rule, one wall of a house could be found and that invariably was lying a short distance to the right of its former position, although some houses were so badly demolished that only the floor could be distinguished and it had been moved some distance. There was more débris to the right than to the left of the center of the path. Haystacks were, as a rule, still standing. Chickens were observed which had been entirely stripped of feathers on one side of the body only. Trees in some cases were broken off a short distance above the ground, but a number of trees had been twisted rather than broken and the base of the tree was shredded. Fence posts were plastered with mud and straw on all sides, and a sheet of galvanized iron that had lodged in a tree was punctured in many places by small pieces of wood which were still in the iron. There were indications of a circular movement, but, due to the destruction being so complete, it was not pronounced as indicated by the direction in which the wreckage lay, although it could be seen that trees had been twisted counterclockwise. Several people who were in or near the storm stated that it was too dark to distinguish the funnel-shaped cloud, but that it appeared to them as a large cloud of smoke approaching. However, many people saw the funnel-shaped cloud from a distance. A number of people spoke of the loud roaring noise attending the storm, and this was heard in Berne, 5 miles away.—*E. W. Holcomb, Indianapolis.*

IN OHIO.

The two tornadoes which were reported to have crossed the State line from Indiana into Ohio are doubt-

less responsible for the damage and loss of life at Nashville, Greenville, Lima, Van Wert, and other towns west and southwest of Toledo. The reports are indefinite, however, and the Weather Bureau observer at Toledo states that there is no authentic record of the funnel-shaped cloud in the immediate vicinity of that place. The total number of deaths reported was 31.

IN LOWER MICHIGAN.

St. Joseph to Gratiot Counties.—During the late afternoon of March 28, 1920, a tornado originated in southwestern Michigan, apparently in the northwestern part of St. Joseph County, and traveled in a northeasterly course for a distance of 100 miles or more. For the most part the path was through farming districts, but it passed through St. Johns, Mich., a town of about 5,000 inhabitants, and several small settlements, including Wacousta and Eureka.

The storm struck St. Johns at 5:08 p. m., 90th meridian time. Those who passed through the storm noted the funnel-shaped cloud, the terrific noise, and other characteristics of a typical tornado. An examination of the débris also revealed the true nature of the storm, as it was distributed in a manner which proved the revolving motion of the winds, some things being carried to the right and others to the left. Many buildings showed the explosive effect, as window glass in many cases was blown outward toward the center of the path, roofs were removed, and the whole sides of several buildings, including a substantial brick factory, were torn away as if by a charge of explosive.

A drenching rain fell after the storm had passed, but no hail was reported in the immediate path. Hail fell in Lansing and at several other points some distance away from the storm, and the hailstones which fell at some points were unusually large, notably near Mason, Mich., about 20 miles east of the path, where they were reported to be as much as 6 inches in circumference.

The width of the path as it passed over St. Johns, Mich., was about 300 feet. No data are available as to width of path at other points.

The property damage in St. Johns and vicinity probably exceeds \$250,000, but there was no loss of life or serious personal injury in that locality, largely accounted for by the fact that the storm occurred on Sunday, when the factories and store buildings, which were demolished, were deserted. Press dispatches mention three deaths near Maple Grove, a few miles north of Battle Creek, Mich.—*D. A. Seeley, Lansing.*

Saginaw County.—Sunday, March 28, about 6:30 p. m., a tornado swept a path about $3\frac{1}{4}$ miles through Saginaw County, on the western outskirts of the city of Saginaw. Fortunately, it passed over a thinly populated district. Four farms were damaged, but no one was hurt. The monetary loss is estimated at about \$20,000.

The funnel cloud first appeared a mile south of Brockway Street, toppling over several telegraph poles. Then moving a little north of northeast it did not touch the earth until it reached John Dirker's farm, where it cut a path about a hundred feet wide between the main barn and dwelling house. On its southern edge it took off the western chimney of the house, sucked off the shingles and rafters from an outhouse, tilted the ice house forward, and wrecked the apple orchard in front of it. Telegraph and telephone poles, fences, and piles of corn stalks were swept away. Evidently the funnel-shaped cloud came down earthward in such a way as to miss the

* Details concerning only two have been received.—ED.

barn and dwelling, but in time to wreck what was in front. The apple trees in the center of the path were bent or snapped northeastward, but on the edges of the path they were twisted in clockwise direction. As one stood in the path of the storm facing northeast, the direction in which it moved, the trees in the center of the path were blown over toward the northeast, or in the direction of the forward movement of the tornado. Along the right-side of the path there were trees standing that had branches farthest from the storm's center twisted backward and inward around the trunk, while the outer branches of trees on the left of the path were twisted forward and inward.

Across Brockway Street on another farm the tornado cut away the southern third of the main barn and took away the southern half of a chicken house, leaving the north half with setting hens untouched. It also blew down the apple orchard here, and the two chimneys on the dwelling house, on the southern edge of its path. It then ascended for half a mile, passing over a tall grove of elms, only tearing off one large branch. But in the bark of these trees were found straws and pieces of wood embedded as much as half an inch.

Hemmeter's barn, a strong building, 95 by 40 feet, lay in a slight hollow northeast of the grove of trees. Here the tornado passed directly over it on one of its low swoops. The barn blew outward and upward, not a single board or beam being left intact. The wreckage showed this clearly, and Alors Franc, a farmer, saw it happen. The débris was scattered for a mile in a clearly defined path from 100 to 150 feet wide, and the rotary action had laid it not unlike a magnetic field. Huge beams and sections of the roof were found more than one-half mile from the site of the barn, embedded in the soil as much as 5 feet. The free ends all tilted inward and backward toward the place of action.

Alors Franc saw the funnel-shaped cloud when it first appeared and watched it as it came straight for his farm. He described the general clouds as black, and the funnel like a gray trousers leg, which rose and fell, and swayed from side to side, was once or twice near the ground, especially when it passed over Hemmeter's barn. The débris was seen to rotate around the funnel like a summer dust squall on a large scale.

Coming directly toward the Alors Franc farm it took a sharp turn eastward, missing the house by only a few yards and doing no damage except that the main barn door was driven inward, breaking the heavy wooden beam which fastened it. The tornado picked up an iron bridge across the ditch, beside the road, and slammed it against the barn on the farm across the street. The farm belonging to Frank Mrakva across Mackinaw Street lay right in the way, and suffered considerably. The tornado cut a third of his barn away as clearly as if a saw had cut it out, tore off the chimneys on the dwelling house on the southern side of the whirl, wrecked an out-house and the apple orchard. The débris from the barn was scattered for a quarter of a mile. On Court Street, a little farther northeast, it apparently had gone up or weakened, for it only blew the windows out of one house, and on State Street it picked up an automobile from the street and set it in the ditch.

The funnel cloud was not seen by John Dirker, owner of the first farm visited by the whirl, but he described the noise as being like a hundred express trains passing by in an instant. Alors Franc, who saw the funnel-shaped cloud from the first, said it sounded to him like a lot of water going over rocks. Both witnesses said there had

been rain, hail, thunder, and lightning, just before the tornado came, but at the time of its passage these had ceased. After the tornado had passed the wind was light.—*Robert M. Dole, Saginaw.*

Shawassce County.—The first observed path of this tornado was on a small knoll 100 yards to the southwest of the farmhouse of A. W. Higbee, about 3½ miles south-southeast of Perry, Mich. A newspaper report that a touch of the storm was felt near Mason, Mich., some 12 to 15 miles southwest of the first observed effects of the storm, has not been corroborated.

The first effects were among a few small fruit trees on the summit of the knoll, from which point the storm tore many shingles off the two main barns on the farm, and demolished the tool barn, all being within a few yards of each other, and between the fruit trees and the house. The house itself was of two parts, an older square, colonial style of heavy-beamed construction, and a newer part of "balloon framing." The new part was an almost total wreck, unroofed, walls bulging, and superstructure gone. The old part withstood the storm remarkably, although severely strained, and with a part of the west wall crushed in by the flying roof from the kitchen porch. This fracture of the wall by the porch roof was so severe as to ruin a bedstead standing against the wall inside.

Several large, beautiful trees standing in front of the house were broken short off at about the height of the main part of the house, a circumstance that gives some strength to the theory that a slight dip in the knoll on the side of which the house stood probably saved the house from complete destruction.

Eyewitnesses here described the storm as coming on suddenly, although there had been rain and thunder for some little time. The first impressions were described as of a very severe hailstorm, with a terrible roaring, inky blackness, and driving rain and hail. This description was corroborated by all who experienced the storm, a terrible driving force, inky blackness, a deluge of rain with driving hail, for just the few moments it took the storm to pass, after which it "was all over," and the normal thundershower conditions again prevailed. Those at one side of the path describe the funnel-shaped tornado cloud in detail.

From the Higbee farm the path of the storm was due northeast for about 2½ to 3 miles; thence turning to the east-northeast, later again turning to the northeast. The total length of the path was about 8 miles, fortunately mostly through open fields, but altogether through a prosperous farming country.

Across the road from the Higbee farm, on the farm of Harry Bridger, a small grove near the house was ruined, though the house being a few feet to one side of the path, was hardly touched. Two barns here were complete ruins, one being crumpled together like a pasteboard box, the other, the main barn, being scattered all over a 160-acre field, with only the iron stanchions left standing. A rafter of this barn was used by the observer to cross a ditch a quarter of a mile from the barn site.

A half mile farther on the storm cut diagonally through a woods lot, cutting a clean swath. The larger trees seemed to suffer even more than the smaller ones, although not a single unbroken trunk was left in the path. In this woods lot the true tornadic action was very evident, those trees which were not uprooted being twisted or broken off. On the southeast side of the storm track the twisting action seemed to have been from right to left, and the trunks were lying mostly pointing slightly inward toward the center of the track. On the northwest

side of the track, however, these conditions were reversed, the twisting action seeming to have been from left to right, and all fallen trunks were lying pronouncedly diagonally inward toward the center. The wreckage in the woods lots visited was almost impassable.

A half mile from this first woods lot the storm cut through another, where the same effects were observed. It was in this second woods, however, that in several instances small, tough branches were observed twisted around the upstanding stumps from left to right; that is, from west around through north to east. These branches were in some instances 2 or more inches thick, furnishing unmistakable evidence of the tornadic action.

Beyond this point the path of the storm for some distance was across open fields, though one orchard was observed to be nearly ruined. Farther on, it was reported, several more barns were demolished. The last report of the storm was about midway between Morrice and Bancroft, Mich.

At no point observed did the width of the path of destruction exceed approximately 100 yards, often being as narrow as 75 yards. The time of occurrence could not be determined within about 15 minutes, all who observed the storm stating that it came "between 5:30 and 6" in the afternoon, the sum of opinions being about 5:40 to 5:45 p. m.

Fortunately, no lives were lost, nor was any one seriously hurt, and very little live stock, the observer hearing

of one cow, two sheep, and one hog definitely lost, and a report not yet confirmed that several more sheep were lost on one farm.

No traces of the storm beyond 4 miles northeast of Morrice could be obtained, and the storm probably did not strike the ground again.—*B. B. Whittier, Lansing.*

Oakland County.—There is little definite information reported concerning the Oakland County tornado. The cities of Fenton and Flint reported serious damage from wind storms. The path as marked on the map (fig. 4) is that reported by the observer at Lansing. Four deaths were reported at Fenton.

IN CENTRAL ILLINOIS.

Logan County.—A tornado occurred in Logan County between 5 and 5:30 p. m. It had its origin near the Sangamon County line, west of Cornland, moved north by 30° east to a point near Broadwell, thence due north, passing just west of Lincoln, and dissipating a few miles north of that city. (See fig. 4.) Its path was about 20 miles long. It seemed to rise when it reached the west boundary of Lincoln and at other places in its path, leaving some places unharmed. Several farm residences were damaged, and there was considerable loss or damage to trees, electric wires and poles, and to barns and other farm buildings. Several head of cattle were killed. The property loss is estimated at \$15,000. Four persons were reported injured.—*Clarence J. Root, Springfield, Ill.*

DISCUSSION OF TORNADO CONDITIONS.

The weather conditions which produced 11 tornadoes in the States bordering on Lake Michigan, and at least two in Alabama and Georgia, are well worthy of study.

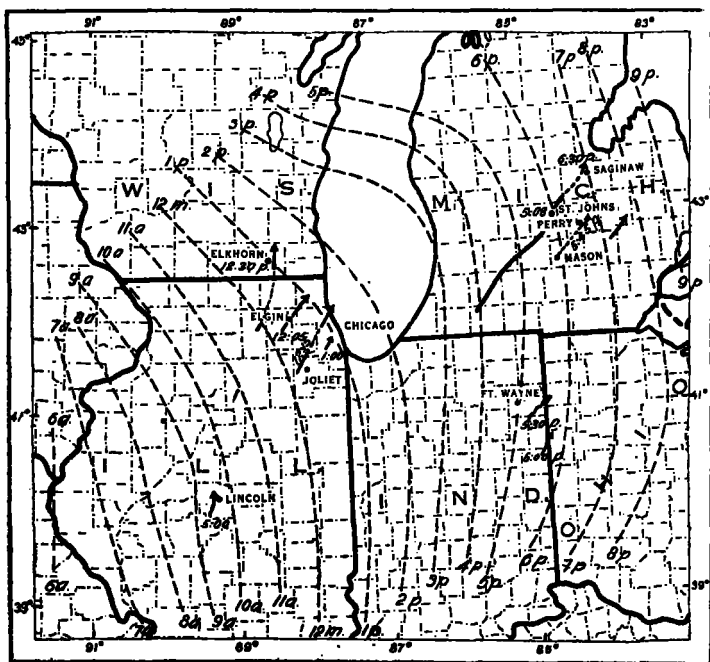


FIG. 4.—Tornadoes in the vicinity of Lake Michigan, March 28, 1920, and the hourly advance of the squall line. (A third tornado was reported in Indiana but its location not mentioned.)

With respect to lower Michigan in which three of the tornadoes appeared, Mr. B. B. Whittier, of the U. S. Weather Bureau at Lansing, made an interesting study of the time of passage of the squall line and lines of first thunder and beginning of rainfall, in connection with

the occurrence of tornadoes. In order to investigate the entire region in which the northern group of tornadoes occurred, his plan has been extended to cover the territory between Iowa and Ohio. Figure 4 shows the area in which the tornadoes occurred with their various paths and with hourly positions of the squall line as it progressed from west to east. These data have been obtained from the original instrumental records of the stations concerned. At many stations, especially those in the southern part of the region, the time of squall-line passage is difficult to determine from the records.

Appearing at 6 a. m. in eastern Iowa, a line of wind convergence advanced on a slightly curved front in a general east-northeasterly direction, reaching the vicinity of Chicago at about 12:30 o'clock. As the squall on this line crossed the Lake, the lesser friction of the water surface enabled the line to advance with increased speed thus creating a forward bulge in this part of the line. (See fig. 4.) In Indiana, this wind front was not so well marked. The last appearance of the squall within the region of the map was at 9:30 p. m. at Port Huron, Mich. Figure 5 shows the wind directions and speeds at various stations as the squall progressed across the region.

The line of first thunder as shown by Mr. Whittier occupied five hours in crossing Michigan, appearing on the east shore of Lake Michigan at 3 p. m. and leaving the State at about 8 p. m. First rain followed thunder half hour later across the State, but the rains were not so general.

A clearer idea of the weather on the day in question in the tornado region can be obtained from a study of the actual weather at a few places. Springfield, Ill., and Grand Rapids, Mich., afford good examples: At Springfield the day began with an overcast sky, with rain during the early morning hours, and a little hail which fell for about two minutes about 4 a. m. But