To combat the situation many hundreds of linesmen were brought in from distant cities to repair the damage on telephone and telegraph lines; traction companies operated with difficulty; some bus lines were unable to operate at all; electric light service was interrupted, failing entirely in many sections; hundreds of automobiles were stalled along the highways; railroad trains ran hours late; all the principal radio stations were unable to operate; large numbers of aerials were down; "Christmas shopping" was interfered with; and numerous injuries and several deaths were attributed to the storms. Rarely indeed has this section been visited by such a procession of severe storms.

Most of the great damage to trees occurred on the night of the 17th and 18th, during a comparative calm; while the greater part of the damage to telephone and telegraph lines followed that date, particularly during the gale on the day of the 20th and night of the 20th and 21st. Damage from all these conditions will be between one and a half to two millions or more; but no one will know for several weeks to come. I think the above is a conservative estimate.

OUTSTANDING FEATURES

Almost incredible quantities of ice accumulated on trees, shrubbery, and other objects. (See special reference thereto.) The streets and boulevards of Buffalo were so badly cluttered up with broken-off branches after the storm that an appropriation of $50,000 was asked for to clean up the city. It will cost I believe, several times that amount to replace trees and trim up those that can be saved. I have seen in other parts of the country damage to telephone and telegraph lines quite as severe as occurred here, but never anything like the damage to trees. All night long of the 17th and 18th one was kept awake by the breaking limbs, which snapped off with a report much louder than a rifle shot. It was a depressing and never-to-be-forgotten experience. Otherwise the night was quiet, there being very little wind.

In 35 years' experience I have never seen Weather Bureau instruments so completely frozen up. The vane and anemometer were heavily caked with ice and put out of commission both at the downtown office and the airport. There was a mass of ice more than 2 inches thick on one side of the sunshine recorder.

The losses mount up, as the work of restoration progresses. I think this is approximately correct:

Total losses in western New York, including the Buffalo and Rochester districts, were around $3,000,000, perhaps more. More than 8,000 telephone poles were carried down by the sleet and wind, with approximately 15,000 miles of wire. The telephone companies alone sustained a loss of approximately $2,000,000.

HAILSTORMS OF 1929 IN THE UNITED STATES

By S. D. FLORA

[Weather Bureau office, Topeka, Kans.]

[Condensed from a report by the author]

Hail damage was severe and widespread during 1929 but not as bad as in 1928, which was one of the worst, if not the worst, hail years in the history of the country. While the total loss by hail for 1929, like that of previous years, will probably never be known definitely, the United States Weather Bureau received reports of more than 225 severe hailstorms during the year with property losses exceeding $10,000,000. The total losses will greatly exceed these estimates from outstanding storms as there were hundreds, possibly thousands, of falls of light or moderate hail, most of them doing but little damage for which no statistics are available.

One of the best indexes of hail damage over the country is the Iowa record, which is compiled from reports collected by the assessors, making that State the only one, so far as known, that knows the amount of its hail loss. This is given in the following table:

Hail damage in Iowa

1923	$2,319,506
1924	6,703,838
1925	7,975,691
1926	2,342,187
1927	5,064,717
1928	6,363,922
1929	[1] 2,354,551

[1] The 1929 figures are estimated from losses paid by insurance companies in Iowa, which were 37 per cent of the losses of the previous year.

There are probably several mid-western States that, if complete records were available, would show as great or even greater loss than Iowa. In Kansas hail losses actually paid by insurance companies in recent years have averaged close to two-thirds the Iowa totals, which include uninsured as well as insured crops, and it is known that a very large per cent of hail losses in Kansas are not covered by insurance. In 1929 hail losses of outstanding storms in Kansas, as reported to the Weather Bureau, totalled $2,403,500, with hundreds of smaller losses not reported.

Hail is always a special menace in Kansas on account of the immense wheat crop of the State, which approaches maturity during the season when hailstorms are most likely to occur. In the western third of the State Weather Bureau records indicate that heavy hail falls three to four times a year somewhere in each 10,000 square miles of area.

Thirty-eight heavy falls of hail were reported in Kansas last year and 15 of these occurred in June, with the wheat crop almost ready for harvest. Even so, the State was more fortunate than in 1928, when it suffered losses of a million dollars or more from each of six hailstorms. Ten of the 1929 Kansas hailstorms caused losses of $100,000 or greater each and one that extended from Byers to near Sawyer, diagonally across Pratt County, on June 13, resulted in a half-million-dollar loss. The path was 1 to 4 miles wide and 30 miles long. Wheat in the area was damaged 20 to 50 per cent.

Two days previous to the Pratt County storm hail fell over a path 60 miles long in Rawlins, Decatur, and Norton Counties, in northwestern Kansas, and almost totally destroyed wheat in some places. The worst of this storm was felt at New Alemelo, Norton County. The total damage was placed at $300,000.

Another of the Kansas hailstorms moved from near Newton to Cassoday, Butler County, on June 12, with the heaviest damage near DeGraff, Cassoday, McLain, and Potwin. The total loss was valued at $150,000. Along the path of severest hail wheat was a complete loss and the oats destroyed in some places. The grain was hammered into the ground until in some fields not a stem was left standing. Chickens, ducks, and geese, as well as birds, pigeons, and jack rabbits, perished literally by the hundreds.

It remained for an eastern State to report the greatest damage from a single hailstorm in 1929. This was a million-dollar loss at and near Hartford, Conn., on August 1, and the greater part of the damage was to greenhouses and the tobacco crop.

A hailstorm in Illinois on May 1 that extended from Cora to Raleigh caused a loss of $720,000. The hail was so severe that roofs were pierced, windows broken greenhouses practically demolished, and fruit ruined over a path 2 to 6 miles wide and 6 miles long. * * *

PRELIMINARY STATEMENT OF TORNADOES IN THE UNITED STATES DURING 1929

By HERBERT C. HUNTER

[Weather Bureau, Washington, January 30, 1930]

In advance of the final study of the 1929 windstorms which is expected to be finished during the coming summer, the following preliminary statement, compiled from the material thus far available from section directors and others, is presented:

TORNADOES AND PROBABLE TORNADOES

	January	February	March	April	May	June	July	August	September	October	November	December	Year
Number	5	5	17	60	37	11	6	4	7	2	0	4	158
Deaths	9	23	20	168	35	2	0	0	0	1	----	0	258
Damage [1]	10	160	352	4,824	1,408	733	32	151	2	4	----	6	7,682

TORNADIC WINDS AND POSSIBLE TORNADOES [2]

Number	1	0	4	5	3	2	2	0	0	3	0	0	20
Deaths	4	----	0	0	3	0	0	----	----	0	----	----	7
Damage [1]	1,250	----	20	20	50	2	(3)	----	----	5	----	----	1,347

[1] In thousands of dollars. [2] Several of these, in the final study, will probably be classed as not tornadoes. [3] No estimate of the damage was obtained for either.

CYCLE RECURRENCES WITH VARIABLE LENGTH OF BOTH PERIOD AND AMPLITUDE [1]

551.501

By CHARLES F. MARVIN

[Weather Bureau, Washington, January 18, 1930]

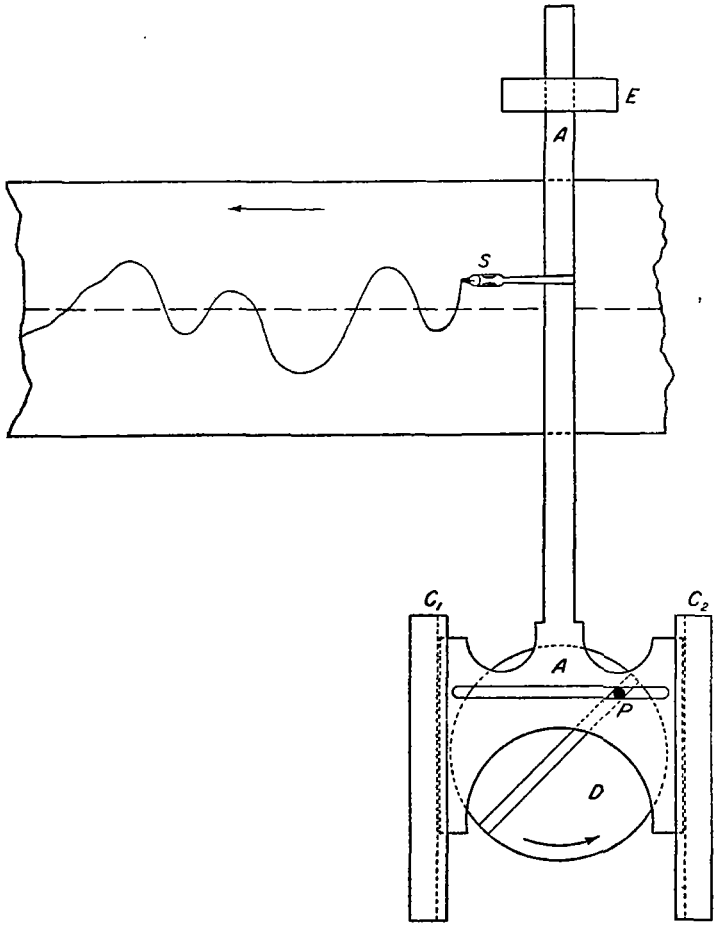

FIGURE 1.—Harmonic analyzer

Following a bit further our interesting discussions of yesterday, concerning cycles and periodicities, I think I would like to state in writing briefly what I tried to make clear in our conversation regarding my conception of the geometrical background or basis for cycle recurrences with variable lengths of both period and amplitude. These conceptions have been in my mind for a great many years, in fact ever since our associate, Mr. Clough, began to advocate his theory of handling periodicities with various lengths and amplitudes.

I think that what I have to say can be made most clear by aid of the accompanying diagram (fig. 1), in which D is a disk revolving about its center, with a movable crank pin, P, which can be either fixed in any desirable position in the slot across the top of the disk, or it can have independent movement to or fro in the slot, either from the center outward in one direction, or from one side of the disk to the opposite, etc. The plate AA is carried between lateral guides, C_1C_2 to the guide at E. This plate carries a stylus, S, for tracing movements of the plate. The crank pin, P, engages a slotted opening in the plate A, and, when the disk D is rotated, gives lineal harmonic motion to the plate A and the stylus S. If, now, a band of paper is moved continuously forward under the stylus S, a record is traced of the combined movements of the paper and of the stylus. When the crank pin retains a fixed position and D is revolved at a uniform rate we have uniform motion of a point in the circle which traces out the conventional trigonometric curve on the paper. It is obvious, however, that if the rotation of the disk D is not uniform but executed in an accelerated and decelerated manner the period of the harmonic curve traced out will be variable and not constant. It is equally obvious that if

[1] This paper was prepared in the form of a letter to Dr. A. E. Douglass, University of Tucson, Tucson, Ariz.