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CONTENTS.

IN the present number of the *American Architect and Building News* an endeavor has been made to present in as brief a space as possible the information which has been gathered from various sources in regard to the origin, character and effects of those destructive storms known as cyclones or tornadoes. Our readers will remember that during the past summer, soon after one of the terrific whirlwinds which have now become of annual occurrence, we suggested the importance of such an undertaking, and as there appeared to be no one else in a position to do the work, we sent circular letters to a number of architects and scientific men in various parts of the country, asking for such information as they might be able to give. This circular met with the kindest response, and although the subject is necessarily still involved in much obscurity, valuable practical suggestions have been received from various sources, and we hope that with the aid of a brief presentation of the latest scientific opinion upon the theory of such atmospheric disturbances, each of our readers will find something in regard to them which he did not know before.

ALTHOUGH the Convention of the American Institute of Architects will be over by the time this reaches our readers, it may be permitted us to speak of it as an affair still incomplete, as it really is at the time our forms are made up. The first day, as usual, is to be devoted to the annual address, by Mr. Latrobe instead of the President, the election of officers, and the reading of reports, with other miscellaneous business. On the second day unfinished business is to be taken up, and papers are to be read, of which we find announced by name in the programme only three: the first being on Some Aspects of the Architectural Work at Assos, contributed by Mr. Joseph Thacher Clarke, Corresponding Member of the Institute and Director of the Assos Expedition; the second on Queen Anne and Georgian Architecture, by Mr. George C. Mason, and the third on Wall and Window Decoration in Domestic Work, by Mr. A. J. Bloor. All of these certainly promise to be interesting and valuable, and others have probably been contributed too late to be mentioned in the programme. The Committee of Arrangements have very judiciously left ample time for excursions to public buildings and other objects of interest, and the Convention promises to be a very successful one.

THE Archæological Institute of America has published a circular to which we are glad to call the attention of architects and other persons interested in the advancement of art and knowledge. Since the announcement, in May last, that definite steps had been taken for commencing the task of excavating the Grecian city of Assos, in the Troad, which has hitherto remained unmolested by explorers, the work has been prosecuted with signal energy and success by the two enthusiastic young architects, Messrs. Clarke and Bacon, who with their volunteer companions composed the expedition sent out and maintained by the Institute; and the temple, one of the few examples of Grecian Doric architecture which, except for occasional references in ancient authors, or the vague accounts of careless travellers, remains almost undescribed, has been so far cleared of rubbish as to make it possible to restore all the parts correctly. Some of the remarkable sculptures with which the building was originally adorned have been removed, and are now in the Louvre, but other fragments of great interest, among them a complete metope, and a large portion of the sculptured frieze, have been discovered and drawn for publication. Besides the excavation of the temple, work has been going on in other parts of the city, and most interesting results have already been obtained. The remains of various porticos and colonnades, devoted to civic or religious use, have been traced; a gymnasium, or training school, in the Grecian sense, has been excavated far enough to expose a large and beautiful mosaic pavement; the Street of Tombs, which has been renowned from the most ancient times, has furnished valuable inscriptions and details, and most remarkable of all, on the banks of the little river which flows by the town have been found the ruins of a stone bridge, dating back to the Grecian period, and forming the only known example of the kind.

THE plan of the ancient city exhibits features which throw a striking light upon the tastes and habits of the early Greek colonists. The acropolis, or fortified hill upon which, as in all other ancient cities, the most sacred and costly public edifices were collected, rises at Assos to a height of some eight hundred feet above the level of the sea. On the top is the great temple, hexastyle peripteral in plan, and exactly resembling in proportions and dimensions the Theseum at Athens, although presenting many peculiar features of arrangement and detail. Two hundred feet below the temple, which was probably once reached by steps like those which led up to the Athenian acropolis, a magnificent terrace is constructed in the side of the hill, looking southward across the Gulf of Adramyttium to the mountains of Lesbos beyond. At its western end stands the ruin of a small temple, while the other was covered by a portico, through which was the outlet to the streets of the city below. Along the outer edge of the terrace ran a paved promenade, bordered on the other side by a conduit or reservoir for water, built of cut stone, and within this, resting against the rocky cliff, which is cut away to make room for them, are the remains of another vast portico or *stoa*, three hundred and sixty-seven feet long, and thirty-nine feet wide, the ceiling of which was supported by a double row of stately Doric columns, among which nearly the whole population of Assos could walk in winter, sheltered from the north wind, and enjoying the sunshine and the beautiful landscape, or indulging themselves in the gossip which was so dear to the Grecian temper. The ruins of this great building show much richness of detail, and the walls facing the sea were probably decorated with paintings and inscriptions, while many statues and ornamental structures, of which the pedestals still remain, filled the whole extent of the terrace. Unfortunately, the bare task of exposing the main features of the city is all that could be undertaken during the season which is now drawing rapidly to its close, and the best rewards of such labor, which come after the preliminary removal of débris is finished, must be left for the next comers, unless a sufficient sum is soon raised to enable the Archæological Institute to continue the work another year, retaining the invaluable services of its present representatives, and what is of hardly less importance, the exclusive privilege of exploration, which was granted to it at the beginning of the present year by firman from the Turkish government. The whole amount absolutely needed is but about eighty-five hundred dollars, a sum which, as the circular of the Institute truly says, is very small in comparison with the ordinary cost of such expeditions, and seems indeed trifling in view of the importance of the work which is already nearly accomplished. No doubt the members of the profession will gladly respond according to their means to such an appeal, and the literary and artistic clubs and societies which exist in countless numbers throughout the country might find great pleasure in contributing out of their general fund to help on an undertaking which so deeply concerns American scholars and artists.

VERY slowly, but, we hope, surely, intelligent persons in this country are awaking to the consciousness that our engineers are, as a rule, at least ten years behind the rest of the world n the planning and construction of sewerage works, not, we hasten to explain, through any lack of knowledge, but from the necessity under which they lie of conforming their practice to a very imperfect degree of public enlightenment. In cities like Baltimore and Philadelphia, for instance, which still enjoy the privy-vault, the cesspool, and the open gutter, it is not surprising that the discussions of foreigners as to the merits of charcoal disinfectants, or special ventilation for repressing the odor from sewer mouths, should appear as evidences of an absurd squeamishness, and the smaller cities, even in the most enlightened States, show a disregard of the most obvious conditions of clean and wholesome living which would strike the inhabitants of a second-rate English town with horror. Of the high sanitary condition which has been reached by the most enlightened municipalities in England no American community can furnish an example; on the contrary, there is no circumstance in the history of our cities more marked than the rapid increase in the death-rate which has taken place within a few years.

As an evidence of the way in which thorough and intelligent measures may serve to elevate the standard of physical and material well-being in a comparatively small community, the sanitary history of the town of Croydon, situated ten miles south of London, is full of interest. Thirty years ago the population of the place was a little over ten thousand, and the manufactures which maintained a considerable portion of the inhabitants were slowly declining. They continued to decline, and are now nearly or quite extinct, but shortly after the period we mention the authorities of the town conceived the idea that its prosperity might be regained by a determined effort to make it, if not very beautiful, or very active, at least a preëminently healthy place of habitation. With this view an eminent sanitary engineer was employed, and a work was carried out which has become famous, not for its cost, which was moderate, but for the skill and thought with which it was planned, the steadfast courage of the town in carrying it out at a time when it must have appeared a doubtful experiment, and the complete success which attended it. The first step taken was the introduction of a complete system of pipe sewers, and the abolition of vaults and cesspools of every kind. Water appliances were rapidly introduced into the houses, and care was taken to see that they were of what was at that time considered a good pattern. Trapping was far less understood then than now, but such protection from sewer-air as was practicable was secured for all the inhabitants.

It was manifestly inconsistent for a town professing a high sanitary standard to pour its filth into the river which flowed at its doors, and in default of any better alternative, the daring step was taken of collecting all the sewage at a point inland, and pouring it daily over a farm of five hundred and forty acres, secured for the purpose, and graded and trenched for the proper distribution of the liquid, trusting to the absorption and reconversion of the organic matter by the roots of plants for the final purification of the flow. This experiment was regarded by the public in general with the gravest apprehensions. Grass grew with amazing luxuriance on the irrigated fields, so that seven heavy crops a year were regularly cut from them, but there were not wanting persons who declared that the hay "had a filthy smell," that "unchanged sewage dripped from the cut stalks," and so on, and who, apparently forgetting the kind of fertilizer commonly used by market gardeners, pronounced solemn warnings against partaking of vegetables grown on the sewage-dressed soil. These forebodings, however, were not realized; the most absurd statements were retracted, and it was not long before scores of other towns imitated the example of Croydon. Meanwhile, the latter city, the pioneer in the movement, had more than realized the hope with which it set out. The tables of mortality soon showed a marked decrease in the death-rate, and the improvement in healthfulness was maintained from year to year. Young married people came and settled there, and the town became remarkable for the number of births, as well as for the small proportion of deaths. In 1870 the population had increased from ten thousand to *fifty-three thousand*, and the number of deaths was barely sixteen per week. In 1880 the ratio of mortality was still diminishing and the city numbered seventy-seven thousand inhabitants, while the little village of Beddington, where the Croydon sewers still discharge, had become an important suburb, with a population of five thousand, and a death-rate, notwithstanding the immediate vicinity of the huge sewage farm, of fourteen per thousand, a proportion which entitles it to rank among the healthiest localities in the world.

A system of hydraulic motors has been introduced into the freight-stations of some English railways which presents many novel features. As every one knows, an immense amount of merchandise is handled at these stations, and it is necessary to provide accommodations for receiving and despatching a large number of cars during the twenty-four hours. With us this would be done by securing ample yard room and filling it with parallel tracks and switches, but ground in London and Liverpool is costly, and the English managers of transportation are more careful than ours to keep the goods entrusted to them protected from the weather, so that it is found more satisfactory to build the structures for the reception and delivery of freight at the more important points in two stories, hoisting the cars bodily from one to the other, to be loaded or discharged. Moreover, space is found to be saved by arranging the tracks for the storage of cars not immediately needed for use transversely to the main tracks, from which they are shifted by means of rows of turn-tables, which will take six or seven cars at once from a train and transfer them to their proper places without the tedious hauling of the whole train back and forth over the switches by which the same object is generally accomplished here, and the transfer of single cars, for which our yard-masters would have to employ a locomotive, is there obtained by the aid of horses or special motors.

For such applications of a moderate power at any desired point the hydraulic motor is found very suitable. The power is derived from one or two accumulators on the Armstrong principle, in which water is pumped into a cylinder under a piston loaded with a weight of thirty or forty tons, furnishing a constant pressure, which is transferred to any part of the freight-yard, or indeed to a greater distance, by means of iron pipes laid underground, beyond the reach of frost. The conversion of this force into motion at the desired points is effected by capstans, similar in everything except size to some of our familiar water-motors, and supplied like a hydrant by a simple valve with a long stem. Posts with revolving caps, like horizontal pulleys, serve to transmit the power in any required direction, and three men, of whom one manages the capstan, the second runs with the rope and hook from place to place, and the third stops the cars at the required point by means of the brake, can move safely a hundred and fifty or two hundred cars every twenty-four hours. The raising of the loaded cars to the store-rooms in the lofts of the freight-houses is accomplished by hydraulic elevators of simple construction, and the water, after having performed its work, is returned to the accumulator to receive a new charge of force. The main supply-pipe is arranged to form a complete circuit, the water in which is always, by hydrostatic law, under nearly the same pressure as in the accumulator, a small loss being caused by friction. Each machine, whether capstan or elevator, takes its supply from the main circuit through a short branch pipe, which is furnished with a valve so that any machine can be cut off for repairs without affecting the operation of the others, and an air-cushion attached to the main conduit prevents water-hammer in the pipes from the action of the machines. The pipes are made of cast-iron, put together with sleeve-joints packed with gutta-percha, and secured by bolts, and tested to about three times the actual working pressure. With our acknowledged skill in making and putting together wrought-iron pipes, it seems as if the hydraulic conveyance of power might be found very useful in this country. The capstans are estimated to furnish from eighty to eighty-five per cent of the power developed in the accumulator, so that this mode of transmission compares not unfavorably in point of economy with that by means of belts or gearing, while it is in many ways much more convenient. There is no limit to the distance to which the power can be carried, and by the introduction of the cheap and simple hydraulic motors now used all steam engines, shafting, pulleys and belts might be banished from manufacturing establishments of the lighter class, to be replaced by one or two lines of pipe, supplied from a street main, and controlled by stop-cocks in a way which is very favorable to precision of workmanship. Already such a system has been introduced into one or two towns of Yorkshire, and the principle is capable of very wide application. Of course any form of hydrostatic pressure could be substituted for that produced by the action of pumps with the same result.

WIND-PRESSURE.

The terrible disaster at New Ulm, Minn., in July last, suggested to us that we might be able to bring about a better mode of building in certain parts of the country if we should direct the attention of architects and builders to such devices as had been employed successfully by others.

The replies which our inquiries have elicited are to a certain extent unsatisfactory, for, while they describe the effect, they convey the impression that the cause is irresistible and not to be avoided. We sincerely hope that if any one has any suggestion to make or wishes to join in any discussion which may grow out of the publication of this issue of the *American Architect*, he will not hesitate to do so.

DESTRUCTIVE FORCES ATTENDING TORNADOES.

Memorandum No. 1. — Prepared for the American Architect by General W. B. Hazen, Chief Signal Officer, U. S. Army.

From the examination of the data contained in the works referred to in memorandum No. 2, it appears that during the passage of a tornado, buildings and other objects are subject to the following destructive forces, viz.: —

I. — VELOCITY, OR FORCE OF THE WIND.

1. From the destruction of bridges, wind-pressures of from 18 to 27 pounds per square foot have been demonstrated.
2. From the destruction of brick buildings, wind-pressures of from 58 to 84 pounds per square foot have been demonstrated.
3. From the lifting up, and transportation, and destruction of loose objects, such as a barrel of tar, a locomotive, a stove, a heavy log, cattle, etc., wind-pressures of 52, 93, 31, 112, and 58 to 83 pounds per square foot respectively have been demonstrated.
4. The upward pressures are occasionally shown to be as great, if not greater, than the horizontal pressures.
5. Downward pressures, or downward movements of the wind have not been clearly demonstrated.
6. Upward velocities of 60 metres per second (135 miles per hour) are not unusual, if we may judge from the effects produced.
7. From observations of the Robinson anemometer, horizontal wind velocities of 80 miles per hour (36 metres per second) have been recorded during tornadoes; subject to a reduction to about 65 miles per hour for possible instrumental errors. But as velocities of 180 miles per hour (reducing as before to 140) have been recorded in hurricanes, there is no apparent reason why the latter should not also be attained in tornadoes.

II. — AREA EXPOSED TO DESTRUCTIVE WINDS.

That the destructive wind velocities previously enumerated are confined to very small areas, such as 10, 20, or 100 feet square is shown:

1. By the narrowness of the path of greatest destructiveness: the destruction of fences, trees, etc., is frequently visible over a path many miles long, but only a few hundred yards wide; but the path of greatest violence is very much narrower than this. The excessive cases above enumerated are observed only in small, isolated spots, less than one hundred feet square, unequally distributed along the central portion of the track; hence in very large buildings, bridges, etc., only a small portion is liable to be subjected to destructive wind in the passage of a storm.
2. In the different portions of this area of maximum severity, the winds are simultaneously blowing from different, — perhaps even opposite — directions, so that the total resultant of the winds at any moment is not so much to overturn or carry off or crush in, but rather to twist around a vertical axis — thus trees are found twisted off, and buildings are generally lifted up and turned around immediately before being torn to pieces — numerous instances of this last action are given in the tornadoes investigated by Sergeants Finley and Mackintosh.
3. As the central area of maximum intensity is comparatively narrow and the chances are very small that a building will be exposed to the violent twisting action, it is evident that the average velocity of rectilinear winds within the general path of moderate destruction is the one most necessary to provide against in ordinary structures. These winds may attain a velocity of 80 miles per hour, over an area 1,000 feet broad, and generally blow from the south-west; those next in frequency blow from the north-west. Of course the tendency of such a wind upon an object whose centre of inertia does not coincide with the centre of figure will be, first of all, to turn it around through an arc sufficient to bring these two centres into the line of the direction of the wind, which partial rotation may occur anywhere within the path of the tornado, and is to be distinguished from the destructive twist that is experienced by bodies that lie in the path of maximum intensity. A similar problem occurs in the case of monuments, stones, etc., disturbed by earthquake shocks, as was first pointed out by Mallet.

III. — THE DURATION OF THE EXPOSURE.

1. The time during which an object is exposed to these destructive winds varies from 6 to 60 seconds — the general average of a large number of cases is 16 seconds — it is therefore probable that the maximum winds at the tornado centre rarely continue longer than the lower of these limits. A building exposed to these winds experiences but one stroke like the blow of a hammer, and the destruction is done. In the case, therefore, of a suspension-bridge, a chimney or other structure liable to be set into a system of rhythmic vibrations, destructive to its integrity, the effect of the maximum winds in inducing such vibrations is reduced to a minimum.
2. The duration of the heavy southwest and northwest winds prevailing over the area of moderate destruction rarely exceeds two minutes.

IV. — VERTICAL WIND CURRENTS.

At the point over which the centre of a tornado stands at any moment, or immediately beneath the funnel or spout that is seen descending from the clouds, there is experienced a strong vertical current whose tendency to destroy and carry upward is greatly assisted by a local diminution in the barometric pressure within the funnel, by virtue of which the air previously confined within a dwelling exerts an outward pressure that is not counterbalanced by the exterior atmosphere. The amount of this unbalanced pressure is, as shown by Ferrel, frequently much more than one inch of mercury or a half pound to the square inch, and may easily amount to ten times this quantity. Of course the interval during which this expansive force is exerted is but a few seconds, corresponding to the time occupied by the central spout in passing along its path, which motion of translation is, on the average, at the rate of 30 miles per hour.

The relative frequency of tornadoes during the months of the year is as follows, beginning with the month of greatest frequency: July, May, June, August, April, March, September, February, October, November, January, and December.

The geographical distribution of 247 tornadoes, from 1794 to 1878, was as follows, viz.: —

New York	24	North Carolina	7	Connecticut	4
Indiana	20	Alabama	6	Michigan	4
Illinois	20	Minnesota	6	New Hampshire	3
Ohio	16	Mississippi	5	Arizona	2
Georgia	16	Maryland	5	Louisiana	2
Iowa	11	Virginia	5	Kentucky	2
Kansas	11	South Carolina	5	Rhode Island	1
Pennsylvania	10	Massachusetts	5	Colorado	1
Tennessee	9	New Jersey	5	Indian Territory	1
Missouri	9	Dakota	4	Maine	1
Nebraska	8	Wisconsin	4	Wyoming Territory	1
Texas	8	Florida	4	Montana	1
				New Mexico	1
	162		61		24
Total				247	

Doubtless the irregularity in this geographical distribution is largely due to the imperfection of our fragmentary records.

The distribution with reference to the time of day is about as follows: —

Between 11 A. M. and noon	4	Between 3 P. M. and 4 P. M.	5
" noon and 1 P. M.	2 ?	" 4 " " 5 "	24
" 1 P. M. " 2 "	7	" 5 " " 6 "	12
" 2 " " 3 "	7	" 6 " " 7 "	7

The remainder are equally distributed at the rate of about two per hour throughout the other hours of the day.

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" 40, 1841, pp. 327–332. Espy, etc., etc. On Tornadoes and Hurricanes.
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" 43, 1842, pp. 122–140. R. Hare. Objections to Redfield's theory.
" 43, 1842, pp. 250–263. W. C. Redfield's reply to Dr. Hare.
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SOME PROFESSIONAL COMMENTS ON WIND-STORMS.

Illinois Industrial University,
Champaign, Ill., Aug. 20, 1881.

To the Editors of the American Architect:

Gentlemen, — I regret very much that so long a time should have elapsed since the mailing of your letter of inquiry, but I hope that this reply will not be too late for your purpose.

1. "Have you ever had any personal experience with cyclones?"

The term cyclone is, I believe, properly applicable to those rotary storms which occur in tropical countries, rather than to the ordinary hurricane or whirlwind which occurs in this country. The cyclone proper is often several hundred miles in diameter, has a calm centre, and has both a rotary motion and at the same time one of translation. I am not aware that a true cyclone has ever occurred in the Western States, since the path of the wind is usually quite narrow and its direction is never reversed, after a calm, as is the case in a cyclone. But the term "cyclone" has been generally applied to the Western hurricane by the newspapers, and I presume that it is too late to change it.

During my residence in this city of a little more than ten years, several hurricanes or cyclones have passed through it, though none of these were so violent as those which sometimes occur in Missouri and western Illinois, since comparatively few buildings have been destroyed, and, so far as I am aware, no lives have been lost directly from their effects.

The first of these occurred during the night of July 31, 1878. Wind from south-west, accompanied by violent rain, 6 inches falling in 20 hours at Decatur, Illinois. Many stacks of grain were torn down, corn and orchards were much injured, a great many chimneys and some smoke-stacks were blown down and a few small buildings were blown over or demolished. About 20 squares of tin roof were torn from the roof of the Main University Building, which was considerably injured by the rain.

The second hurricane visited the city on March 27, 1880, at about 7 A. M. A dark cloud approached from the south-west accompanied by a visible, funnel-shaped whirlwind. Path of the greatest force of storm appears to have been only about 12 rods wide, but just before reaching the city it divided and impartially treated both Champaign and Urbana alike, having a width of more than a mile, as the intensity of the storm appears to have been the same in both cities. A great many trees were broken down, small buildings crushed, chimneys destroyed, a large mill smoke-stack wrecked and some small houses were moved several feet from their foundations. The tin roofs were also torn from several of the largest business buildings and thrown into the street, breaking glass, etc., and causing some very narrow escapes, but no loss of life.

The Mechanical and Military Building of the University is a brick building and is mostly two stories in height, with a hip roof of about $\frac{1}{4}$ pitch, covered with tin. The shops are in the lower story and the drill-hall, 124 x 60 feet occupies most of the upper story. The roof of the drill-hall is supported by 12 trusses of wood, of 60 feet clear span, and which are spaced $9\frac{1}{2}$ feet apart between centres. Purlins 4 x 6 inches are placed at right angles to the principals of these trusses, to which they are fastened by gains and spikes. These purlins are about 4 feet apart. On the purlins is laid the sheathing, of ordinary matched inch flooring turned upside down, and laid parallel to the principals. This is then covered by a tin roof laid in the usual manner, excepting that it is held to the sheathing by about twice as many cleats as usual.

When this building was struck by the cyclone, a student had just entered to commence work in the shop, and hearing the racket he ran out and saw the tin and wood-work of that portion of the roof which gave way, still attached to the building but extending vertically upward in the air and swinging around in a circle, just as if it were acted upon by a whirlwind. It soon gave way and the mass was pitched across the street, striking in the University Campus, and as some of the purlins struck the ground vertically they penetrated to a depth of about three feet. Of course, the mass was a complete wreck. Three bays or spaces between trusses on the south or windward side of the building were entirely uncovered, everything being removed but the trusses, which were uninjured. The heading joints of the sheathing were not properly broken, but were made on the same purlin, and the purlins were only fastened to the trusses by gains and a few spikes. Consequently, the whole was removed. There was no previous opportunity for the wind to get inside the building so as to exert an upward pressure on the roof as all the windows were closed and the building is reasonably air-tight. An ordinary violent wind which acts in a horizontal direction would exert a downward pressure on the roof, thus holding it in place.

The effect of the wind can only be explained on the supposition that it was a true whirlwind, exerting a violent suction upwards. This kind of wind occurs with comparative rarity in this country, and is one to which no attention is paid in the text-books, which always proceed on the assumption that the direction of the wind is nearly, if not quite, horizontal.

Had the joints of the sheathing been properly broken and the purlins firmly fastened to the trusses, the weight of the trusses would have held the wood-work in place, and perhaps the tin roof also. When the roof was repaired, I had the purlins firmly spiked in place and pieces of $\frac{1}{4}'' \times \frac{5}{8}''$ flat iron with a quarter twist at centre were screwed to the sides of purlins and principals. These irons were put on over the entire roof, so as to avoid any such mishap in future.

Total damages in Champaign and Urbana caused by this hurricane amounted to several thousand dollars.

The third and last hurricane of importance occurred at about 1 o'clock on the morning of April 19, 1880. The direction of the wind was southerly, veering to south-west, and it was probably more violent than during either of the preceding storms, as greater damage was done by it. A great many signs, awnings and chimneys were blown down, the tin roofs completely torn from several large brick stores, and several small wooden houses were moved off their foundations. Several plate-glass windows were broken by the pressure of the wind, which I never knew to happen before. The iron roof of the county court-house was partially torn off, and a portion of the brick wall of the county poor-house was blown in, falling on the inmates, who escaped with some severe cuts and bruises. Trees and shrubbery much injured. About fifteen squares of tin roof were torn from the Main University Building.

The principal dormitory building of the University was a large brick building mostly five stories in height, cross-shaped in plan and covered by a tin roof of about $\frac{1}{4}$ pitch. It was erected sixteen to eighteen years since. The walls were of varying thickness, but in the upper story were composed of two thicknesses of eight inches each, separated by an air-space of about $1\frac{1}{2}$ inches. The masonry was as good as the average, but the two walls were not very carefully bonded together, no hoop-iron bonds being used. These hollow walls were plastered inside without lathing or furring. The western wall which gave way was strengthened by hollow brick piers at the angles of the building about three feet square, and also by two brick partition walls eight inches in thickness. The width of that end was about forty feet and there were three windows in each story, of medium size. At that time the building was occupied as a dormitory by some eighty or ninety persons.

The wind came first from the south, afterwards gradually changing to the south-west, and came in violent gusts, striking the west wall at an angle of 45 degrees. Suddenly, at about 1 o'clock, the upper half of the end or western wall fell outwards against the wind, causing considerable excitement and a hasty removal from the building but no loss of life. This was probably caused by a heavy gust which forced the wall over against the rest of the building and when the pressure diminished, the momentum of the wall and the reaction of the building carried the wall over beyond its original position and it fell outwards. The building remained in this condition until morning when the roof was seen to be loose and as the violence of the wind had not diminished, it could not be secured and some 20 feet in length were torn off completely.

The total damages from this last cyclone probably amounted to $8,000 dollars in the cities of Champaign and Urbana.

Two sources of danger to buildings from excessive wind-pressure were shown to exist, by the effect of the last two cyclones, and which I do not remember to have ever seen discussed in the text-books or elsewhere.

1. The effect of a whirlwind, which produces a rotary motion, acting upwards and tending to lift the roof bodily off from a building.

2. The tendency of an outer wall of masonry to react during a momentary cessation of wind-pressure after a violent gust, and to fall outwards from the building.

The maximum wind-pressure which occurred here during the three cyclones is not known, as no means existed here at that time of measuring the pressure or velocity with accuracy.

On October 13, 1880, a station of the United States Signal Service was established at this university, and a continuous record has been kept since that time. The maximum velocity of the wind which has occurred since that date is 48 miles per hour, which corresponds to a pressure of about 12 lbs. per square foot according to Smeaton, or only 8 according to Hagen. (Appleton's *American Cyclopædia*, Vol. 16, page 660.) This maximum pressure has occurred at two different times, but no damage was done.

2. "Have any buildings designed by you either succumbed to or withstood cyclones?"

None of my buildings have ever been injured by cyclones in the slightest degree, so far as I am aware, though they were as fully exposed as any others. Some are large wooden houses, built with balloon frames, and placed on cellars or basements of brick, — but if these are properly constructed, they appear to resist excessive wind-pressure better than brick buildings, unless these are very massive, because more elastic. The chemical laboratory of the University, the largest of my buildings, is about 73′ x 110′, built of brick, with stone basement, four stories high, and is located just east of the main building, and is subject to the same exposure, but not even the tin roof has ever been injured. I attribute the immunity of my buildings to their being strongly constructed, to their having good foundations, to the roofs being anchored to brick walls by iron rods, and to care being taken to have the cornices air-tight, and to prevent access of the wind between the tin and the sheathing.

3. "What devices have you ever employed in your buildings for withstanding excessive wind-pressure?"

I presume that by excessive pressure you mean forty or fifty pounds per square foot, and acting horizontally, as this is usually assumed as the maximum effect of wind by scientific authors, such as Rankine, Unwin, Dubois, Clarke, Greene, etc.

Buildings could hardly be so constructed as to certainly resist the effect of any possible cyclone without materially changing their form, thus making them less suitable for their purpose, and also considerably increasing their cost, both of which propositions would doubtless be promptly vetoed by their owners.

The devices which I have employed to resist excessive wind-pressure are the following, which are not novel by any means: —

a. Great pains has been taken to get a good solid foundation, always proportioning the widths of footings to the weight of wall and load, making the cellar-walls of brick or stone, and levelling them up carefully, so as to give a good bearing to the superstructure and to prevent the access of air beneath the building.

b. I have always tried to strengthen the walls as much as possible by projecting portions of the building, so as to avoid having too much wall-surface in a single plane, also by cross-partitions; in wooden buildings, by sheathing the frame outside before weather-boarding, so as to stiffen the wall, as well as to make the building warmer.

In the chemical laboratory the rough or deafening floor was laid on the joists, stripped on top and the interspaces filled with mortar, and the usual floor laid on the strips. I had the rough floor laid diagonally, at an angle of 45° with the joists, instead of at right angles as usual, which materially strengthened the walls, because each floor acts as a brace to the building, which acts as a single mass in resisting the wind. All the joists were also anchored to the walls.

c. All roofs have been firmly anchored to the walls. This was done in brick or stone buildings by carefully bedding the plate on top of the wall and then fastening it down by $\frac{3}{4}$-inch rods, three or four feet in length, and placed eight or ten feet apart. These had a large cast-iron plate on the lower end and were built into the wall, and the nut on upper end screwed down on top of plate. In the case of a mansard tower, additional precautions have been taken. Twelve to sixteen feet below the top of the wall, a strong oak timber was built into the masonry across the angle, showing about its width internally, but not visible on the exterior of the building. Then a $1\frac{1}{2}$-inch rod was placed in the inner angle of the masonry, and its lower end passed through a hole in the timber and secured by a large washer and nut. The upper end of the rod was forged out flat, and was firmly bolted to the side of the lower end of the hip-rafter. Each angle of the tower was anchored in this way in addition to the bolts through the plate, already mentioned.

This method was employed to strengthen the towers of the Main University Building, and has been entirely successful.

d. I have taken great pains to have cornices air-tight, or to have the air shut off by furring, so as to keep it out from between the tin roof and the sheathing. If the wind does obtain access, it acts like an hydraulic press, setting up a great upward pressure all over the roof, and as this is only resisted by the cleats, the roof is soon torn off and the building is liable to be damaged by rain. I have seen a dozen men stand on a loosened tin roof of a few hundred superficial feet, during a violent wind, and the tin was lifted by the wind as if there were no weight upon it.

This danger of being torn off by wind is the principal local difficulty that I find in the use of tin roofs, and it is easily obviated.

4. "What means of construction for resisting wind-pressures, employed in this or other countries, have you ever heard of or read about?"

Very few special means have been employed, to my knowledge. I have heard that the Tip-Top House on Mt. Washington, where the velocity of the wind is sometimes one hundred and fifty miles per hour, was constructed with very thick stone walls, and that its roof was anchored down to the rock by heavy iron cables, but have never seen the building. Light-houses are also often built on wrought-iron piers, connected by iron diagonals, so as to avoid wind-pressure as much as possible, or they are anchored by loading the lower story with sand.

Very few architects pay any special attention to the effect of wind-pressure on a building, as may be proved by the curiously inefficient types of roof-trusses, and their misproportions, which may be seen in many buildings which are commonly supposed to be scientifically constructed.

In the works of Culmann, Ritter, Ott, etc., the wind is supposed to act in a direction nearly horizontal. Its effect is divided into two components, horizontal and vertical, and the vertical component is added to the other vertical loads, which are supported by a roof-truss. The horizontal component, which often reverses or materially changes the strains in the members of the trusses, is entirely ignored and its effect neglected.

In his *Applied Mechanics*, Rankine assumes the loads on trusses as always vertical, and only considers the effect of wind-pressure on towers and chimneys. — *App. Mech.*, p. 240.

It is but recently that more nearly correct views have prevailed, since the general introduction of graphical statics, and as given in the works of Unwin (*Iron Roofs and Bridges*), Clarke (*Principles of Graphic Statics*), Sankey (*Notes to Translation of Ritter's Iron Roofs, and Bridges*), Dubois (*Graphical Statics*), Greene (*Roofs, Bridges and Arches*), etc. In these works the wind-pressure is divided in two components, one acting parallel to the roof surface, and exercising very little influence on the building, and which may therefore be neglected without material error.

The second component acts normally to the roof surface, is taken as acting in its actual direction and being combined with the other contemporaneous forces, their true effect on the building or the exact strains on its parts are readily found.

But in all the works last mentioned, the mode of obtaining the intensity of the normal component from the maximum horizontal pressure is based on an old empirical formula, which was deduced from results of experiments by Dr. Hutton, and which is assumed to be accurate, though some results obtained by it are evidently incorrect, and it is based on imperfect experiments, made long before the introduction of the methods and apparatus which have enabled physicists to attain a reasonable degree of accuracy in experimentation.

In fact, the whole subject of the pressure of wind on surfaces of different areas, forms, and inclinations to its direction, is in a very fragmentary and unsatisfactory state.

In my opinion, very little attention is paid to the effect of wind upon buildings in Continental Europe, because heavy winds seemingly occur there very seldom; otherwise, the old wind-mills, towers, etc., which are scattered over the country, and some of which have apparently been in a ruinous condition for centuries, would certainly be blown down.

5. "What devices can you suggest, even if you have not tried them yourself, for resisting cyclones?"

If buildings were to be erected for that purpose alone, it would be most economical to make them subterranean, or, if above-ground, to construct them of paraboloidal or hemispherical form, keeping the exterior as smooth as possible, so as to offer the least amount of obstruction to the wind; also to make them air-tight, anchoring them firmly to the ground, taking great care to prevent the wind from getting under them. But as buildings are primarily erected for convenient use, and are not constructed to resist cyclones, I can only reiterate the precautions already mentioned: —

1. Insist on good construction throughout.
2. Have good foundations, of stone or brick, anchoring down small wooden buildings.
3. Do not permit the wind to find admission beneath the building.
4. Strengthen the walls by projections, pilasters, cross-partitions, and by construction of floors.
5. Anchor floors and partitions firmly to the walls.
6. Always anchor the roof to the walls, taking special precautions with the roofs of towers.
7. Provide means of ventilating attics so as to relieve them of excessive wind-pressure, which tends to lift the roof.
8. Prevent access of air between tin roof and sheathing.
9. Never allow tin to be laid in courses of more than twenty inches, and have about twice as many cleats put on as usual.
10. Always work out strains in trusses, purlins, rafters and sheathing, and proportion the dimensions of parts accordingly.

I have not illustrated the preceding remarks by sketches, because these did not seem to be necessary.

Very truly yours,

N. CLIFFORD RICKER,
Prof. Architecture, Ill. Ind. Univ.

QUARTERMASTER-GENERAL'S OFFICE,
WASHINGTON, D. C., July 23, 1881.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Sirs, — In reply to your questions in regard to effects of cyclones and precautions to guard against them: —

1. I have never been in a severe cyclone. Twice I have seen in Washington severe thunder-storms, with gales of wind which overturned hundreds of trees and took the tops out of others. Each of these took off in this city about two hundred tin roofs, and blew down some frail brick walls, generally in unfinished houses.

2. Some buildings at Fort Brown, Texas, designed by the Quartermaster's Department, were injured and partly destroyed on the 12th August, 1880, by a cyclone, or at least a severe hurricane. Particulars are given in a report, of which an extract copy is enclosed. Most of the b ldings destroyed were of wood. The hospital and the cavalry barracks and light artillery barracks were of brick.

3. I have not had cause to build any important structures in a region specially liable to cyclones. The cost of a building proof against all such storms would be far beyond the provisions made by Congress for barracks and quarters and storehouses for the United States Army.

4. In hurricane latitudes, buildings are kept low and are made with very massive walls and heavy roofs. Storm-houses as refuges are, I understand, sometimes constructed below ground, being exca-

vated and roofed with heavy timbers and earth, or even with massive arches. To these, in a severe hurricane, the family retire for safety.

5. The devices which insure safety are those given in answer to Question 4. But such buildings are not pleasant habitations, and are too costly to be adopted for habitual habitation. People prefer light, air, and space, with some risks, to safety with the deprivation of all these; except when for a few minutes the storm is upon them.

I may add that a hurricane demolished a light-house at Key West, on the Florida Reef, before the war; but it is impossible to say whether this was done by the mere force of the wind or by aid of the waves of the sea, which ran over a good part of the island of Key West.

A locomotive, it is alleged, has been overturned by the wind on one of our Western railroads, and I have noted repeated reports of railroad-cars blown off the tracks. I have seen the ruins of brick houses in Brownsville, Texas, which I was told were blown down by a hurricane some months before my visit. The walls, as I remember, were eighteen to twenty-four inches in thickness. But there were other houses on the same streets, which appeared to be no heavier, which had withstood the storm.

I am of opinion that no reasonable, convenient, and economical dwelling or barn is safe against the vortex of a violent revolving cyclone, and yet such storms often leave quite slight buildings comparatively unharmed. I am, respectfully,

M. C. Meigs,

Quartermaster-General, Bvt. Major-General U. S. A.

[Extract from report of the Commanding Officer at Fort Brown, Texas, dated 15th August, 1880.]

I have the honor to report that this section of country has been visited by a hurricane which has wrought serious damage and great pecuniary loss.

Upon the evening of Wednesday, the 11th inst., the roaring of the gulf was distinctly heard here. The wind blew fresh from a point a little east of north during the entire night, and early the next morning the rain began to fall. At 9 o'clock, A. M., the 12th, the wind became strong, and the rain descended vigorously. A gradual increase of wind and rain took place during the entire day and until half past eleven o'clock that night. At half past ten o'clock in the evening the anemometer at the Signal Office indicated the velocity of the wind at forty-eight miles an hour, and then broke down. At half past eleven the wind and rain ceased very suddenly, and a calm prevailed until one o'clock, when the wind sprang up from a direction directly opposite; the rain again began to descend, and at two o'clock the storm was as furious as it had been during the earlier portion of the night. It continued until half past five o'clock in the morning of the 13th, when it gradually died away. A slight rain, unaccompanied by wind, continued until ten o'clock, A. M., of the 13th. The record of rain-fall at the hospital shows 5 8-10 inches, but the guage probably did not indicate the fall correctly because of the high winds. The Post Surgeon thinks that fully seven inches of rain fell, while the city of Brownsville reports the fall at thirteen inches.

The damage done to the cities of Brownsville and Matamoras is very great. Many buildings were blown down, and their contents destroyed or badly injured. Matamoras seems to have suffered more than Brownsville, as some of the finest buildings were ruined.

At this post the damage is serious. Every storehouse, excepting the one belonging to the Ordnance Department and an old Quartermaster's building, have been completely wrecked. Every stable, except a small unoccupied one, fell down, burying horses and mules in the ruins. All the barracks, with the exception of the one occupied by the cavalry company, were partly unroofed and otherwise injured. All the laundresses' quarters, with the exception of three, were totally demolished. The hospital building lost its chimneys and its ridge ventilators. The administration building, two of its chimneys, part of its porch roof, and a small portion of its wall. The officers' quarters suffered mostly from the falling of plastering; and those constructed of brick, from the shaking and cracking of the walls. This damage was done after night-fall, and mostly all between the hours of nine and eleven o'clock. The Quartermaster's stables fell about nine o'clock, and it was impossible to relieve the buried stock, which consisted of thirty-three mules and twelve horses, until midnight, when all were dug out. Three horses and one mule were found dead, and three horses and two mules permanently injured. The roof of the cavalry stable was caught by the timbers of the mangers, and none of the horses were much hurt. The laundresses' quarters fell at about the same hour; but a short time previous thereto the families had sought shelter in the cavalry barracks. The roof of the Subsistence Storehouse (properly the Ordnance gun-shed) blew off about ten o'clock, and the side wall fell in. This exposed the stores to the driving storm during the remainder of the night. The Quartermaster's clothing and tool house was utterly wrecked, and the property therein greatly damaged by the rain; this was the new storehouse recently erected. The wind lifted it from its foundations, and carried it about six feet beyond its walls. In fact every building with open foundations was carried away, excepting the infantry company barracks. There the wind was broken by the brick walls, or fence, in rear, and the lattice work beneath them.

At the commencement of the storm the river stood at about fourteen feet above low-water mark and rose to fifteen feet during its continuance. The water flowed over the banks near the corral, and we were obliged to wade through it to get at and release the stock. . . .

All communications with the post has been cut off. Nearly everything at Brazos has been swept away. If the steamer arrives, she cannot discharge her freight, and the railroad connecting that point with this, has been temporarily destroyed. The wagon roads have been rendered impassible by the rains. Every steamboat upon the river, but the "Andrew Ackley," has been wrecked.

Chicago, July 26, 1881.

To the Editors of the American Architect: —

Sirs, — Acknowledging receipt of yours of July 21st, I have to state that my personal experience with cyclones is rather limited, though I have followed newspaper accounts with a good deal of interest. Some fifteen years ago a slight touch of a cyclone destroyed two very strong chimney-tops of a school-house building. The cyclone directly thereafter descended to the earth, raised a hogshead filled with rain water and upset it. It then, as I judged, rose to a height beyond the tops of buildings and disappeared.

In August, 1873, I was with a company making the first trip from Fond du Lac to Sheboygan on a railroad train. Some ten days prior to this there had been accounts in the newspapers as to considerable damages being done in the former city by a cyclone, accompanied, as they ever are, by a thunder-storm. This storm had taken its course along the railroad toward Sheboygan, as was evident by destruction in the forest at the west side of the road. I could plainly follow its course for a distance of at least three miles. For a distance of about 400 feet in length, in a course about 70 feet wide, there lay scattered every tree and shrub, extracted from the earth. They lay there in every direction, plainly indicating a revolving circle, of about 70 feet diameter, which has gone forward in its motion. At the termination, there lay only the highest trees, the lower ones remaining untouched. The cyclone then — the particular *one* which did this destruction — had risen beyond the height of the trees, passing on its way in the air. A little farther on there was destruction of trees and shrubs in a circle of about 40 feet diameter. The cyclone having done this, seemed to have darted downwards and risen immediately again beyond the tops of the trees. After that the first cyclone seems to have descended again to a destruction of an area of trees and shrubs not more than 150 feet long. Then followed several cyclones which merely touched and uprooted the higher trees, always scattering them in the direction of a circle. The total result was the destruction of trees on an area aggregating about a mile in length and 50 feet in width. This was done by about eight or ten cyclones of different diameters on a track about three miles in length. The track of these cyclones seemed parallel with the railroad. What other places of destruction there were, if any, beyond the narrow lines of sight from a railway car, I was wholly unprepared to estimate.

I can suggest no devices that might overcome the force of a cyclone, which actually uproots the largest trees, lifts locomotives off their track, raises whole smelting furnaces, and deposits them at another spot a rod away. It might be tried to split them up by large missiles from a gun. But perhaps these missiles might require to be so large, though not very heavy, that the remedy, if it be any, becomes impracticable. Waterspouts, we all know, are severed and destroyed by large cannon-balls.

If it be agreeable to learn the theories I have to advance on the subject, I will state the following:

1. There is no thunder-storm without a number of cyclones accompanying the same. The severer the storm, the larger the number and diameter of the cyclones.

2. Under peculiar circumstances a limited number of cyclones will descend, and striking the surface of the earth, destroy objects in their path with a force almost unlimited.

3. A large cyclone striking the surface of the ocean will raise in its rarefied centre a column of water to a height of, say, 14 feet and swiftly turning the same will screw the water to the height of the cloud whence the cyclone has descended. A heavy cannon-ball, well directed, will split the column and destroy the waterspout. This explanation of the waterspout is generally admitted — is not a new one.

4. Large cyclones, being below the cloud which sends rain through them, will convert the rain drops, traversing their rarefied and consequently cold centres, into grains of hail. The deeper such cyclone in itself, the larger the grains. Truly yours, F. Baumann.

Lima, O., August 10, 1881.

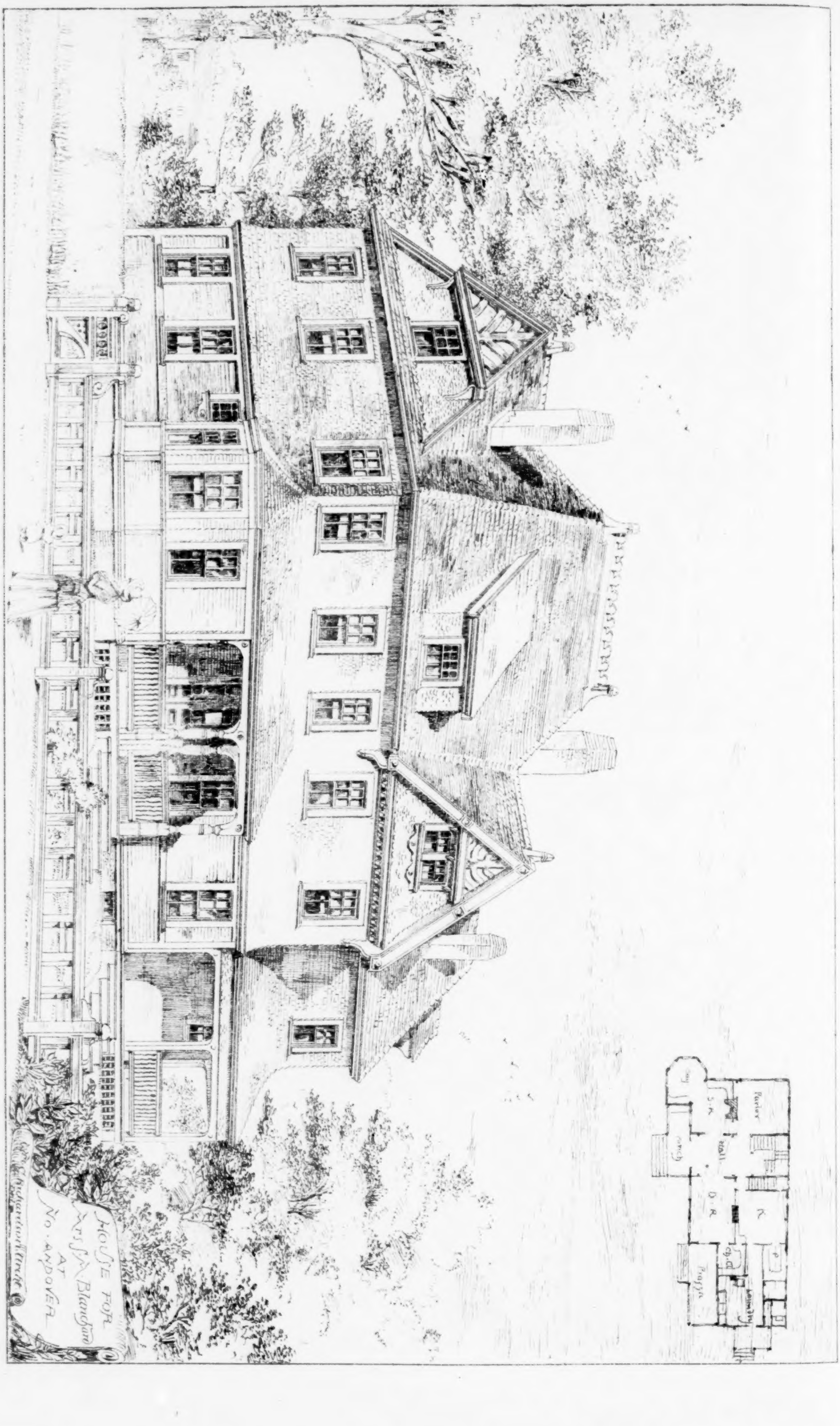
To the Editors of the American Architect: —

Dear Sirs, — In reply to your circular regarding cyclones I would say that I have had no experience with the destructive effects of cyclones in any buildings designed by me, nor in the examination or restoration of buildings so destroyed, but the following from accidental cursory observation may serve to indicate a few instances where further information may be elicited.

I have only employed the means which ordinary prudence suggests, based on a maximum wind-pressure of 40 pounds per square foot of exposed surface, in anchoring turrets, spires, and other prominent parts. This is probably as high a factor of resistance as a prudent regard for economy of construction in ordinary buildings, in ordinary localities, and with a due regard for the chances of a building escaping the path of cylones, would seem to require.

Four or five years ago a cyclone visited Fort Madison, Iowa (on the Mississippi River), doing considerable damage. The German Catholic brick church was unroofed, or partly so, the spire and upper part of the tower being blown down; several other buildings suffered more or less. I happened to be passing in the train about half an hour after this happened. I do not know height of tower, spire, thickness of walls, methods of anchorage, etc. In the same year, I think, a cyclone visited Burlington, Iowa, cutting away one corner of a brick dwelling, 12″ thick walls, I think, and doing considerable damage about the C. B. & Q. R. R. premises. About a year afterwards, a wind storm — it could scarcely be called a cyclone — blew down the second and third stories of the gable of the Court-House at Keokuk, Iowa. The wall was brick, 12″ thick. The wind had access to the inside of Masonic Hall in third story through open side windows.

I believe it is generally noticeable that the path of the less destructive and most frequent cyclones has been comparatively limited. Others again are less frequent, but more destructive, sweeping away whole towns and villages, and are generally of broader area. I think that frequently destruction is caused by the wind having access to the inside of buildings through its doors or windows. I heard of a case in Minnesota, while there recently, of a stone barn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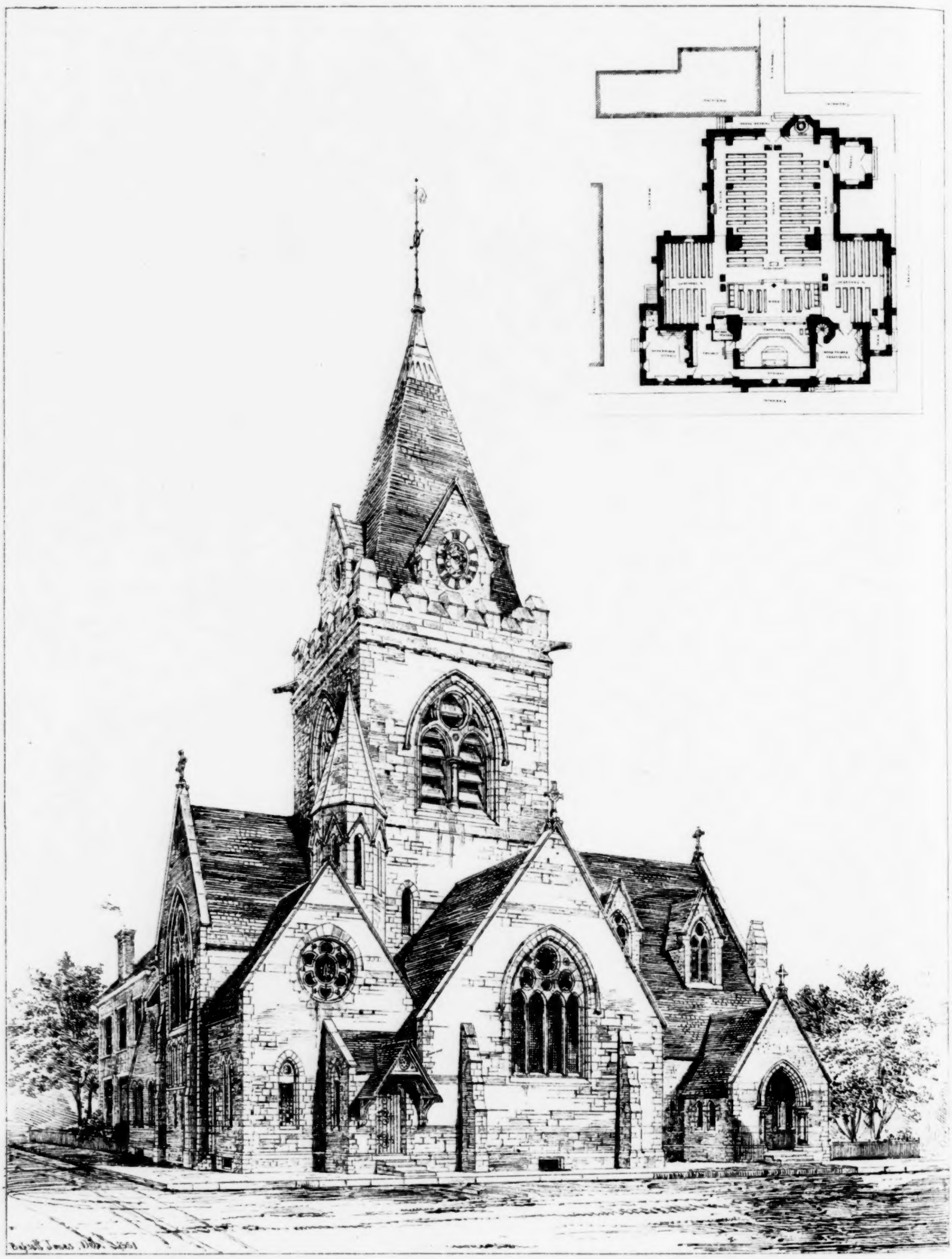

The Heliotype Printing Co. 211 Tremont St. Boston

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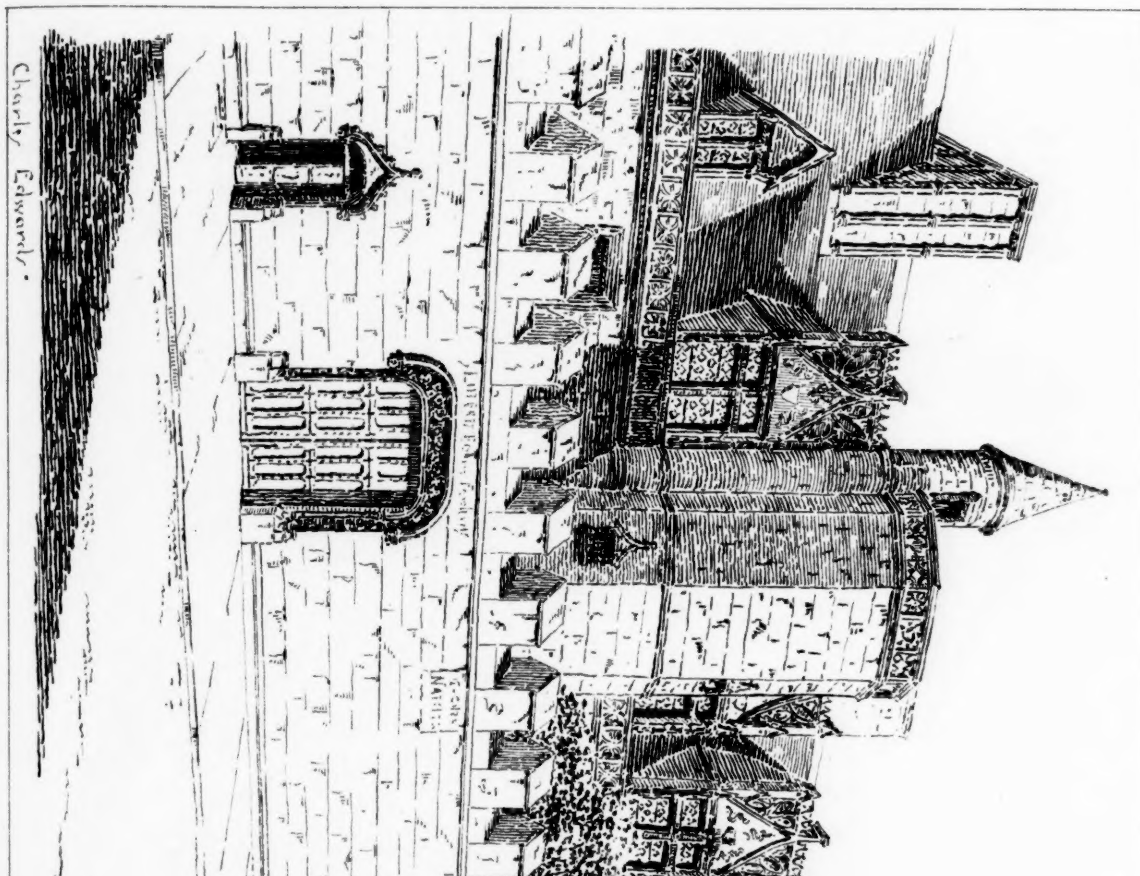
H. M. Congdon, Architect, N.Y.



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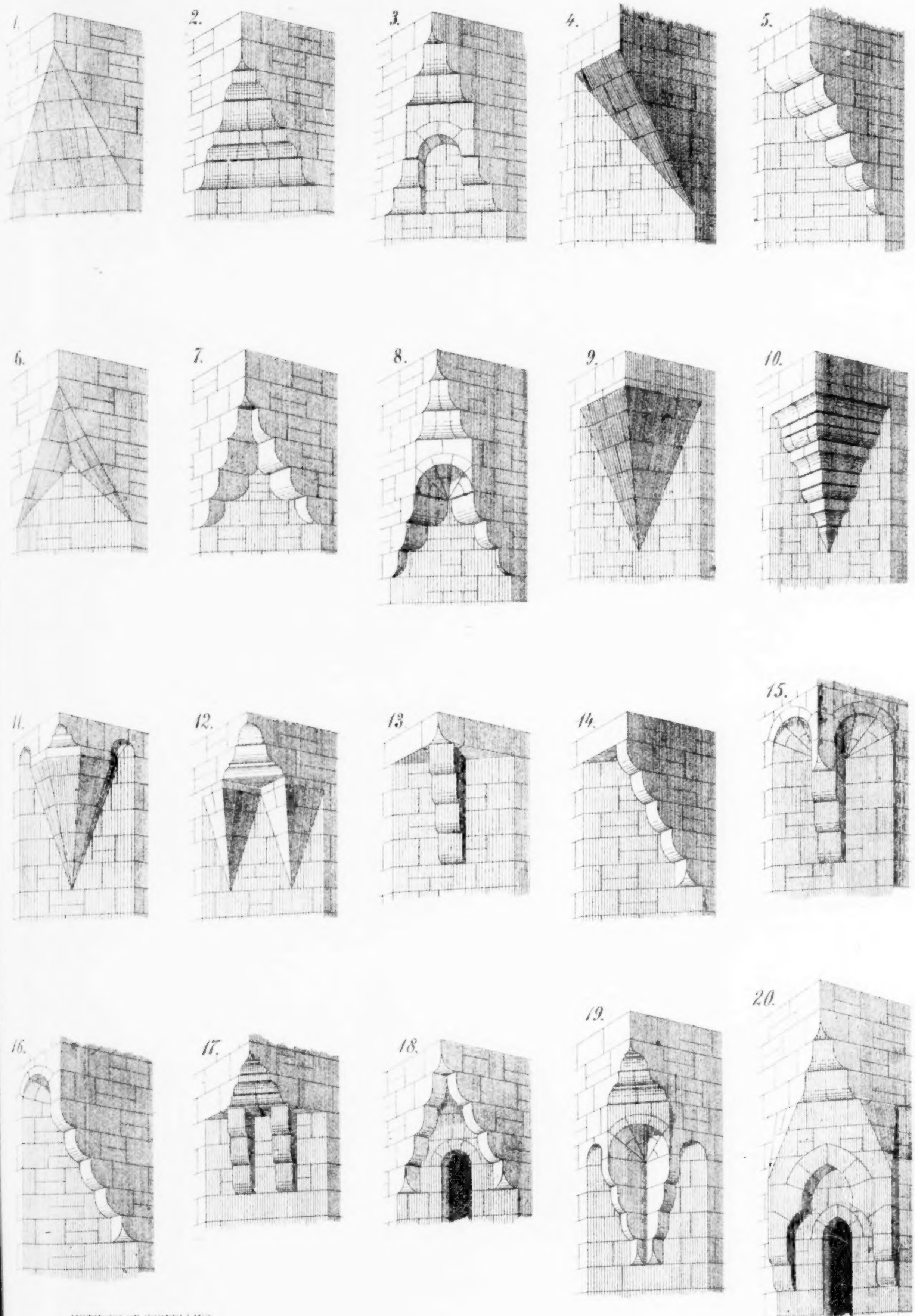

METHODS OF CORBELLING

From the oblique side of an octagon, or the chamfer-plane at the corner of a tower, to the corner of the square above.

The Heliotype Printing Co. 211 Tremont St. Boston.

being levelled to the ground. The walls were two feet thick, and not over fifteen feet high; the wind had access through a wide door, and blew off roof and with it the walls to which it had been anchored. In Minnesota and Dakota, I understand, anchoring ordinary buildings is better attended to than in less exposed States.

Perhaps one of the important points which might be elicited in your present inquiry is the static effect of cyclones which produced destruction of buildings at different points. The late General Myers of the Signal Service endeavored to arrive at this solution in some of the more notable cases, but we are still very far from possessing adequate static deductions on this subject, so far, at least, as I am aware of. I might add that the general subject of wind-pressures seems to require more accurate and extended instrumental observation, which the United States government could readily afford the necessary facilities for obtaining, at its exposed signal stations. In the most noted cases it would seem that the destructive energy is resistless by such materials and construction as is ordinarily available within the means of a very large majority of the people who build; nevertheless it is worth while inquiring how far any of the methods resorted to in tropical climates periodically exposed to the vicissitudes of cyclones could be available in the circumstances. Yet to effectually resist them seems futile in the face of the fact that most of the destruction is precipitated by the parts of a building which must, as of necessity, be vulnerable — the *windows* and *doors.*

Yours respectfully, ALEX. BLACK.

ST. LOUIS, August 18, 1881.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Sirs, — In reply to your queries about cyclones, I have to say that I have had no experience with them, and have no knowledge of any precautions, other than the ordinary rules of construction, against them. No great damage has ever been done by wind in this city. I will send a pamphlet with a reliable and valuable account of a cyclone which visited neighboring counties in Illinois in 1879. [See extracts below.] The observers were scientific men. One eye witness, a lumber dealer in Collinsville, relates that the wind did not blow down his lofty lumber piles but that the top layers of boards were lifted vertically up into the air and there split into fragments. Two feet in height were thus removed from the top of the piles, the lower part being undisturbed. Very respectfully, C. E. ILLSLEY.

THE TORNADO OF APRIL 14, 1879.[1]

THE weather map of the Signal Service, for 7.35 A. M. of the 14th of April, shows that a well-marked barometric depression existed over south-western Missouri, and over Indian Territory and south-eastern Kansas. It was central about 60 miles north-west of Fort Gibson. During the day this area moved to the north-east, and at 4.35 P. M. it was central near Marshfield, Mo., about 170 miles south-west of St. Louis.

Shortly after midnight of the 13th–14th, a light rain began in the region around Glasgow, Mo. This rain area extended outward in all directions, the front of the rain-storm forming at 4 A. M. an oval or ellipsis, the major axis of which extended from a point somewhat north of Lexington to near Fulton, lying thus in the Missouri bottoms. The length of this major axis is about 150 miles. The minor axis was at the same time about 50 or 60 miles in length. The velocity with which the front of the rain-storm advanced was then about 25 to 30 miles in the direction of the major axis, and from 15 to 20 miles per hour in a direction at right angles thereto. [At the same time a rain in the Indian Territory had extended into south-west Missouri, the two rains apparently mingling in the Osage valley at about 9 A. M.] The amount of rain was on the average one-fourth of an inch, and the duration from half an hour to an hour and a quarter. It reached St. Louis at 7 A. M., where the rainfall was only a tenth of an inch. In the western part of the area the rain was heavier, being 0.8 at Kansas City.

This rain thus existed first as an *area,* and was continued as a slowly enlarging belt, or *elliptical ring,* on the inside of which the rain had already ceased. This seems to indicate a descending current of air, which, striking the earth, spread thus outwards, its front being marked by a rain-cloud.

At noon, a rain area, precisely similar to the former, began at Chamois, 80 miles south-east of Glasgow, and about 60 miles west of St. Louis. The major axis of this rain area was almost due east and west, extending at 1 P. M. from a point about midway between Sedalia and Warrensburgh to St. Charles. The northern boundary of the rain passed at this time near Mexico, the southern being about midway between Chamois and Rolla, in a region not represented by observers. The rainfall was in this case somewhat greater than in the morning. It was most violent at the extremities of the longitudinal axis, being 0.83 at Chamois, reaching a maximum of 2.75 at Sedalia, 100 miles west of Chamois, and increasing also rapidly to the east, being 1.92 inches at St. Louis. Farther to the east, in Illinois, the rain was also very violent, but no observations were made upon it.

The facts above given are all clearly shown by the observations of the Missouri Weather Service. The progress of the second rain is represented on a small map on Chart No. 1, which shows the time of beginning of the rain and the amount of rain in inches.[2]

At St. Louis the rain-cloud appeared in the west shortly after 1 o'clock, and at 2 P. M. heavy rain and hail with thunder and lightning began, the hail-stones averaging half an inch in diameter at Washington University. Some of the hail-stones were one and a half inches in diameter. At this time the wind was from the north-west. The hail ceased at 2.10, and the rain ceased at 2.20. The wind in the meantime had for a short time reached 40 miles per hour; it quickly subsided to 10 or 15 miles per hour. At 2.20 the clouds overhead appeared much broken, the surface wind and lower cloud (scud) moving from the north-west, while the upper clouds came from the south-east. Although broken overhead, a smooth and somewhat luminous rain-cloud was coming rapidly up from the west; its front was of a green color; it had the appearance of being a thin cloud, through which the sunlight was transmitted in unusual quantity. At 2.35 heavy rain and hail again began, the hail being somewhat smaller than before, but in greater quantity. At 2.42 the hail again ceased, and at 2.50 P. M. the rain ceased, the total rain and hail having been 1.92 inches.

[The description of the manner in which Mr. Nipher conducted his investigations and deduced from them his conclusions is so discursive that it is impossible to reproduce it here. The gist of his observations seems to be that he distinctly proved the existence of several nearly contemporaneous cyclones, travelling in converging and diverging lines, and centering in or near Collinsville, and producing the following material results.]

. . . .

We now return to consider more clearly the effects of these vortices in Collinsville, for here it is, by a singular coincidence, they all concentrated. Commencing with the principal line where it entered town, the first point is at 1.[3] A light wagon picked up and whirled around, the shafts broken off; direction of motion opposite the motion of the hands of a watch with the face up. At 2, one-and-a-half-story dwelling crushed but not scattered, débris inclined in direction of storm; seven trees in this block lay in line of the storm, one south and one outbuilding north. 3. Building at the corner scattered, the next thrown several feet in line of storm. 4. A trench excavated by the vortex, 12 feet long, 20 inches deep, also in line. 5. A barn, that has never been found; several trees all in line. 6. Double one-and-a-half-story frame dwelling lifted six feet high and set down angling upon the foundation, as evidenced by the cellar-stairs, attached to the floor of the house, which were carried over a partition-wall in the cellar and not broken off. 7. A similar building utterly crushed and scattered; here a life was lost and two persons wounded. 8. A two-story double brick; the front part had its walls thrown outward, but not scattered; here was evidenced a peculiar application of force not unlike explosion; trees north and north-west. 9. A one-story brick dwelling, solidly built, with whole of north front thrown outward, while the roof remained in place, and the house was otherwise uninjured. 10. An interesting example: a one-story frame dwelling had to be entirely rebuilt; it was found literally shaken apart, but not entirely separated, excepting the porch, which was thrown down; outside walls all bulged outward: the plastering all shaken off; roof had shingles all loosened, but not shaken off. 11. Three-story brick, with half-a-dozen bricks taken out just under the coping of the cornice, and nothing else disturbed. 12, 12, 12. All brick dwellings, showing some evidence of explosion, but scattered and more or less swept away from the premises. 13. One-story brick exploded; this was more marked than any other (see special references further on). 14. One-story frame, the same. 15. A sign carried westward; very few instances where débris was taken in this direction. 16. Roof, the same. 17. A single light of glass in a show-window burst inward by a jet of wind only large enough to cover this light of glass, and this occurred on the east side of the building. 18. A large one-story frame hall and reading-room, 60 x 75, moved off its foundation, and not specially injured. 19. Several articles removed from porch on south side of building inclosed on three sides, open only to the south, and taken to the north of the house. 20. Here all the trees and sidewalks carried north; frame house exploded on east side; a small plank penetrated a heavy brick wall in second-story of 20 1-2 D 2. 21. A one-story frame with the *east* wall pulled off some eighteen inches, some glass burst outwards, and no other injury involved; chimneys secure.

We have only enumerated peculiar phases or conditions, and made no attempt to describe the damage inflicted. Among the many singular incidents we select a few only.

At Mr. Cox's, just west of town, after tearing away part of his barn and some fifteen trees, it raised the roof of his dwelling (one-and-a-half-story) at the eaves, and snatched a pair of pants, a shaving and a soap box, and deposited them on the hood of an awning that projected over his front door, the roof settling back nearly to its place again.

We have a piece of corn-stalk, 3 inches long by 3-4 inch wide, that had been driven through the hard, painted surface of an old door three-fourths of an inch thick.

At a blacksmith's shop, north side of Main Street, lay the bed of a light wagon, the running gears being in the second story of a wagon-shop, on the south side of the street, that was utterly crushed and scattered some 300 feet distant, and where they were being painted. After the storm they were found to the east, *side by side, and uninjured.*

A horse and buggy, standing in front of a church in which a funeral was being conducted, was taken up into the air and whirled 260 feet distant, and dashed to the ground, killing the horse and but slightly injuring the buggy. Some bystanders claimed that this horse and buggy were carried fifty feet high.

In block 13 and 14 there was a two-story brick business block, covered with a tin roof, the rafters and sheeting of which were carried across the street, while the tin was found spread out upon the upper joists, a few inches lower than its usual position. The explanation probably is that a first gust of wind tore the tin loose and tumbled it up on one side; a second was sufficient to remove the sheeting and rafters without reaching to the tin rolled up on one side; while a third current threw it back into the last position named.

On the west front of Temperance Hall are a number of nails driven to various depths head first.

On the west end (facing the storm) of the office in a lumber-yard, small pine splinters, smaller than pipe-stems, are driven into the siding.

The next building east of 19 was pierced in two places through its walls by rafters from some of the destroyed buildings in the other end of town.

Two of my neighbors (Messrs. Miller and Patton) had purchased a property and divided it. On the division line there stood an out-kitchen. Just before the storm they were devising means to dispose of it, neither desiring to take it. A moment later there was a decision from the supreme court: the building was torn to pieces and scattered, while the two-story house was only shaken up severely.

Very many other instances of singular escape and coincidence occurred, but they have no special bearing on our subject.

According to your own published reports, the storm reached St. Louis at 2 o'clock, P. M. Continuing from this point, we find it pursued an even course with the same velocity, reaching Collinsville, 10 1-2 miles east, at 2.35; Lebanon, 21 miles east, at 3.00; and Highland, 29 miles east, at 3.30 (St. Louis time). It would seem that the necessary elementary conditions for the development of the tornado were found over the American Bottom, and that this development was purely local, and did not exceed much over ten miles, and had no apparent influence over the general storm that was passing at a higher altitude to the eastward. That it consisted of a principal vortex, of very considerable power, accompanied by six collateral vortices, of much less power, that seemed to *possess more than an incidental relationship to the principal,* and a second principal vortex apparently independent in time

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[1] Extracts from the pamphlet by J. L. R. Wadsworth, M. D., and Francis E. Nipher, and referred to by Mr. Illsley above.

Dr. Wadsworth has collected all the information in regard to the effects of the tornado, a work which his intimate acquaintance with the witnesses has enabled him to do with great success.

[2] It is hoped that this will be sufficient to show all of our observers how important it may be to determine accurately the times of beginning and ending of all rains, even when they appear to be insignificant. It should also be stated whether the time given is St. Louis, Chicago, Jefferson City, or *local* time, in order that corrections for differences of time may be made with more accuracy than has been possible in case of the ones given above.

[3] The numerals refer to a diagram which is not here reproduced.

and direction. That the direction of the principal vortex was 15° north of east, and, while there was a probable swaying to the one side or the other, the paths of the vortices were in straight lines. It will be noticed that the first four collateral vortices are *convergent* upon the path of the principal vortex, and that the two last are *divergent*. That the principal vortex was in contact with the surface while it was receiving the first four, and that it had left the surface before it gave off the last two collateral vortices. The height of the principal vortex was about 500 feet; the collateral were comparatively small. The rotary spiral motion was in the direction opposed to the movement of the hands of a watch, and of great velocity. The progressive motion was about one mile a minute. It had also a vertical or lifting motion, which was often quite abrupt (and proved the most interesting part about it to the writer, for by this motion he escaped destruction). The path was narrow on the approach to Collinsville, about 100 feet, gradually widening, and the vortex at the same time exhibiting less force. At the zinc works it was 600 feet wide. Its lifting power was sufficient to carry large roofs at least 600 feet high; this, with a power equal to the momentum of a body moving sixty miles an hour, would carry heavy débris some distance. The effect of these motions was to break up every object it carried up with it; even lumber, taken up free from all contact with anything else, would come down, in many instances, kindling wood.

An interesting phenomenon in connection with the tornado, and covering a large proportion of the destruction attending it, comes from a peculiar "explosive action."[1] To illustrate: a one-story brick building (as at 13, D. 2), protected on the west, 20 feet distant, by a tall, substantially built brick block; on the east, 20 inches, a one-story frame; and 15 feet from the last, a two-story brick. Now the vortex struck the brick block on the west, tearing off the roof and the west wall down to the second floor; then, rising and inclining upwards, it took the brick partition and the east wall, the latter extending nearly to the top of the second story; next passing over 13 and 14 (the one-story building), but striking the next brick building, and cutting off the fire-wall above the roof. The line of destruction was evenly and plainly marked, and the débris was scattered (some of it) a long distance. This line was above 13 and 14, and yet what was the result? At 13, the east wall leaned over at the top, resting against the west wall of 14, 20 inches distant; the north-west and south walls lay on the ground, as if they had been evenly pushed over outwards, the roof attached to the upper joists in their normal relation; the east end of these joists rested on the wall that leaned against the next building, and the west end rested on the floor, which had not been moved; no part or portion had been carried away; the furniture and clothing all left and not scattered; two persons under the leaning joists and roof uninjured. No. 14, built of wood, had the gables burst outward, but again there was no scattering.

In about thirty minutes after the vortex had passed, there was a return current from the north, bearing a very severe hail and rain-storm, accompanied by a most terrific electrical display. There was no electrical disturbance — as would be indicated by lightning and thunder — connected, in any manner, with the vortices.

Storm Lake, Iowa, Aug. 1, 1881.

To the Editors of the American Architect: —

Dear Sirs,—Yours of the 21st inst., asking for information in regard to cyclones or tornadoes, is received. I wish I were able to give you more information about them than I am. They come upon us without much warning, leave as suddenly, and leave nothing but their destructive track behind them. In answer to your first question, I have had some personal experience with cyclones, on two occasions. Three years ago a very destructive one passed through this neighborhood destroying everything in its course. The track of the storm did not exceed forty or fifty rods, I think, but everything had to succumb to its violence. Houses, trees, fences, wagons, and all kinds of farming implements were lifted from the ground and literally torn to pieces in the air, and the fragments in some cases being carried a distance of two miles. I did not receive any great amount of damage from it, although its course was through my place and within half a mile of my house. Quite a number of persons were killed at that time. One child, a lad of about twelve, was carried over a quarter of a mile through the air, and dumped, very unceremoniously, on the prairie, and strange to say, though badly injured, was not killed, but eventually recovered.

The second one in my experience was about four weeks ago, but was not nearly so destructive in this vicinity, though in other localities, mostly at Cherokee twenty miles west, it did an immense amount of damage. I appeared to be right in the track of this one, but did not receive any serious damage; I think from the fact that there is quite a rise of ground at the back of my buildings, which caused the most of it to pass over head. It took away the barn of my next neighbor, crossed the Lake, on the west bank of which my place is situated, and demolished a house on the opposite side. I was in a direct line between the two places. I thought for an instant everything would go, but with the exception of a few trees blown down and some damage to fences I escaped. That was a straight wind. The one three years ago was a regular whirlwind, a "*genuine twister.*"

Second: No buildings designed by me have succumbed to cyclones, but I am certain it is only for the reason they were not in the track of one.

Third: I have never employed any special device for withstanding wind-storms. I always try to the best of my ability to make my buildings strong. I have never had one either fall down or blow up as yet.

Fourth: I don't call to mind at the present time of having heard of any devices being employed in the construction of buildings for the purpose of making them secure from damage by cyclones.

Fifth: I don't think I can suggest any device that would be at all practicable for the construction of buildings to withstand cyclones. I have no doubt you will receive many schemes from your correspondents for that purpose, but a person who has never witnessed the progress of a cyclone can have but a faint idea of the immense power developed by such a storm. It is possible that a building, circular in form, without any projections, might withstand its force, but one would hardly find many persons willing to adopt such a style of building. We, out here in this country of tornadoes, think a hole in the ground, about the safest place to retreat to when we hear one approaching.

I am yours very truly, Henry Fisher.

Topeka, Kansas, July 25, 1881.

To the Editors of the American Architect: —

Gentlemen, — In answer to your letter of inquiry concerning cyclones I have to reply:

1. That since the establishment of our office in this state in 1857, we have had no personal experience with cyclones properly speaking; but have witnessed some pretty stiff breezes, the worst of which occurred two years ago, reaching its maximum at Lawrence, where several frame dwellings were blown down, the spire of the Baptist Church was thrown to the ground, and a portion of the roof of the State University was uncovered, the framing remaining intact. We have no record of the force of this wind as the anemometer was blown from the University building, but it has frequently shown a record of a velocity of sixty miles per hour, or equivalent to a pressure of 17.7 lbs. per square foot. The church spire referred to had shown signs of weakness in the brickwork at the top of the tower for several years. We do not know how it was constructed.

2. A portion of the roof was taken from an Indigent Asylum, built from our plans in the Cherokee Nation, by a cyclone.

3. We have used no particular device to withstand cyclones, other than we think should be used to make substantial work under ordinary circumstances. We secure church spires by first bolting the main wall-plate to the top of the wall with $\frac{3}{4}''$ bolts, 3 feet long, hook and lug at bottom, nut and washer at top, set once in 5 feet. Then the hip-rafters are secured to plates, and by additional rods bolted to sides and extending down from 10 feet to 16 feet in corners of tower to bell deck, passing through heavy timber built into the wall, then by means of diagonal bracing from hip to hip, spiked and bolted, we make the frame-work of the spire one solid mass; but in addition to this the mason-work below *must be substantial*, or the spire is liable to fall.

4. We have no device to suggest, the use of which would resist the force of a cyclone, nor do we attempt any. The cyclone proper has a whirling motion, and sometimes goes bounding and skipping over the surface of the earth. To illustrate, buildings have been taken from their foundations, raised many feet into the air, whirled about and set upon the ground again without much damage. I have been told by a reliable witness that during a cyclone in Ottawa, Franklin County, Kansas, a corn-crib was taken from its foundation leaving the floor, but taking the corn. The building was raised about ten feet, into the air, then replaced in almost exactly its former position. A neighbor's cooking stove was found in the centre of the corn subsequently. Sometimes buildings are literally torn to pieces, and the débris scattered for a half a mile, while small articles are carried for miles. I only mention these points to show that there is no basis upon which to figure to resist a cyclone, no two being alike in their action or effect. Then we tell our clients that we will not attempt to build against a cyclone, but only against steady, heavy winds from any one direction; this we succeed in doing. Take, for instance, one of our first-class frame dwelling houses: first a 2″ x 8″ wall-plate is bedded in mortar on the top of the wall, the joists are placed upon this and spiked to it, also being spiked together on partitions; the studding, 2″ x 6″, are set 16″ between centres, one along-side of each joist, lower end resting on plate, spiked to plate and joists; then the foundation wall is carried to top of joists; the ordinary "way board" is used to support the second floor joists, and a 2″ x 6″ plate at the top. The outside walls are then boarded on the inside and outside with $\frac{7}{8}''$ surfaced white-pine sheathing strongly nailed. The partitions are not boarded; but are braced by cutting in a 1″ x 7″ strut making it flush with the studding; we make them as long as possible, putting them wherever they can be got in. The studs are doubled at corners and openings; the ceiling joists are simply spiked to the top plate, or secured to a "way board" beneath the plate, as the case may be, in half-story houses; the collar-beams form the ceiling joists, then the rafters rest upon the plate alone. This house may be built 40 feet high to the top of the ridge, and will not vibrate enough to crack the plastering in the strongest wind that we have had in Topeka for ten years.

Now let us review the house that shakes until you roll out of bed, (figuratively), and blows down.

First, then, joists 2″ x 8″, 2 feet apart, 18 feet span, bridged once through in a slip-shod manner. Studdings 2″ x 4″, 16″ apart, standing on a shoe (2″ x 4″) laid along on the top of joists, all insecurely nailed. No braces, no boarding inside or out, common sidings $\frac{1}{2}''$ thick at one edge, $\frac{3}{16}''$ thick at the other: usually a story-and-a-half house with 1″ x 4″ collar-beam on rafters, say three-fourths of the way up, rafters 2 feet apart and the lathing put directly upon

[1] This is sometimes attributed to rarefaction of air outside of the house, the unbalanced internal pressure throwing the walls outward. To say, under the conditions which obtain in a tornado, that there is a tendency to rarefaction at the centre of the vortex, is equivalent to the statement that the wind is blowing. In case of a vortex approaching a building, the inrushing wind would cause a great pressure on the windward side of the house, and the pressure on the lee side would be less. The breaking of a window on the windward side would transmit the pressure to the interior. The support of the side walls would cause the lee wall to be most vulnerable. The side walls might also be started outwards, and the reverse winds, after the tornado has passed, would tend to throw the remaining walls outwards. The violence of the wind, would, of course, determine the distance to which the ruins would be scattered.

them. With this goes a chimney that you might run a lath through without touching mortar. See the difference! The only wonder is that they wait for a cyclone to assist them in falling. A prototype in mason-work of the latter case would be about a 13″ wall that I saw not long since, 150 feet long, 16 feet high. Workmen were cutting some openings through it at intervals of from 10 feet to 16 feet. One could see through it from end to end edgewise between the bond courses.

Upon this basis the following opinions are formed:

1st. One cannot build securely against a cyclone.

2d. All heavy winds are not cyclones, although magnified into such by newspaper reporters, and *victims*, as much of their own penuriousness in building, or the "skullduggery" of contractors as of the wind.

3d. Any well-constructed building will withstand the pressure of a 60 mile wind without material damage.

Since writing the above I have ascertained that the anemometer at the State University recorded a velocity of 90 miles per hour previous to being blown off during the gale or cyclone referred to above.

Yours etc., L. M. WOOD, *Architect.*

THE ILLUSTRATIONS.

HOUSE FOR MRS. S. M. BLANCHARD, NORTH ANDOVER, MASS. MR. W. C. RICHARDSON, ARCHITECT, BOSTON, MASS.

THIS little house, situated in North Andover, which is to cost $4,200, is finished in white wood, and has cathedral glass in stair window, high window in sitting-room, and front doors.

CHRIST CHURCH [MEMORIAL], DANVILLE, PA. MR. H. M. CONGDON, ARCHITECT, NEW YORK, N. Y.

METHODS OF CORBELLING FROM THE OBLIQUE SIDE OF AN OCTAGON, OR THE CHAMFER PLANE AT THE CORNER OF A TOWER, TO THE CORNER OF THE SQUARE ABOVE. COMPILED BY PROF. CHARLES BABCOCK, ITHACA, N. Y.

These drawings illustrate some of the actual and possible methods of treating one of the most picturesque features of mediæval castellated architecture. Nos. 2, 5, 7, 9, 10, and 14 frequently occur. We have noted no examples of the others, but they are all practicable.

HOTEL DE CLUNY, PARIS, FRANCE. SKETCHED BY MR. CHARLES EDWARDS, NEW YORK, N. Y.

CYCLONES IN THE UNITED STATES DURING THE CURRENT YEAR.

WE have not pretended to keep a complete file of the disastrous cyclones that have occurred in the United States during the present phenomenal year, but we find that we have the following fragmentary record:

June 12, 1881. Heavy storms in Iowa, Kansas, Minnesota and Missouri.

July 16, 1881. The destruction of New Ulm, Minn. Thirty persons killed, 1,000 buildings wrecked.

New Ulm was composed largely of brick buildings, more so in proportion, it is said, than any city or village in Minnesota. These buildings were demolished as though they were corn-cob houses; whole business blocks were completely destroyed, and every metal roof in the city was blown off. The larger part of the wooden buildings, especially the balloon-frame structures, stood intact before the gale.

August 27, 1881. Hurricane doing great damage on the Georgia and South Carolina coasts.

September 25, 1881. A terrible hurricane struck Elmira, N. Y., at 4.30 P. M. accompanied by a severe storm of rain. A vast amount of damage was done in about two minutes, the duration of the storm. Entire roofs, with their heavy timbers, were blown hundreds of feet; the Rathbun house was unroofed, and the spire of Hedding Methodist Church was blown across the street into a yard. About two tons of brick were deposited in the organ of the First Presbyterian Church. Several brick buildings had holes blown clear through them. The storm was preceded by an earthquake.

Sept. 26, 1881. About 4 o'clock P. M. a cyclone laid desolate the village of Camden Ill., a place of several hundred inhabitants, about twelve miles west of Rushville. The wife of Dr. Watts was killed instantly by the falling of the walls of her house. But two houses in the place were not injured more or less. The total loss in the village is estimated at $40,000. Two churches, Methodist Episcopal and Christian, with a seating capacity of four hundred each, were completely demolished. Along the entire path of the storm dwelling-houses and barns were torn and twisted into all shapes. Trees, orchards and hard-wood timber groves were completely riddled, and in places cornfields appeared like stalk-fields in early spring, after being pastured by droves of cattle. Corn was blown out of the husk and scattered broadcast. It is estimated the loss to the farming community, within five miles of the village, is $15,000. The storm lasted but five minutes. It was accompanied by heavy hail and sheets of rain.

September 28, 1881, Stanton, Neb., was nearly destroyed by a cyclone.

September 29, 1881. A tornado swept a valley a short distance west of Wautoma, Wis., on Thursday, completely devastating a space eighty rods wide and five or six miles in length. Many houses, barns and out-buildings, and one grist mill were demolished. About a dozen persons were seriously injured, but nobody was killed outright. The damage to property could not be closely estimated, but would exceed $50,000.

Accounts from Omaha, Neb., and other points in that section, report the cyclone of Thursday as terrific in its force. Nebraska City was damaged several thousand dollars' worth, the Blind Asylum and several business blocks being unroofed. The injury at Omaha was comparatively trifling.

November 11, 1881, two passenger coaches of a Colorado Central train were blown from the track, two miles east of Georgetown, Col., by a severe wind storm. The coaches were badly smashed.

It is asserted that buildings with peaked roofs escaped serious injury in the cyclone which so greatly damaged the town of New Ulm, Minn., while neighboring square-roofed buildings were wrecked.

FORCE OF THE MINNESOTA CYCLONE.

THE following letter was written from a place three and one-half miles northeast of Fort Ridgely, by Herbert A. Gates, one of the Minneapolis and St. Louis surveying corps, to the St. Paul *Pioneer Press:* "On Friday, the day of the storm, we were surveying a preliminary branch running a westerly course from the main line, when we saw quite a large black cloud approaching. We started for camp, and were within about three miles of it when the cloud in the centre turned green and purple; lightning flashed and heavy thunder rolled. About a mile from camp the heavens looked like an immense cloud of dust. We got in just in time to unhitch the horses from the wagon when the storm struck us. Seven of us tried to hold the tent, but failed. We were scattered in a short time in all directions. Henry Wales was thrown against a tree and had his left side smashed in. The wind hurled me through the tent as it fell. I tried to hold on to a tree, but in vain, and was thrown about four rods against more trees, and this time I stuck, while the air was filled with sticks and iron flying in every direction. One of Finley's boys was about sixty rods north of us with a large herd of cattle. He was carried into the air and cast to the ground lifeless. When found the only article of dress he had on was his shirt-collar. His father's house was entirely destroyed. A mile southeast of us lived a family named Oliver. The father, mother, and four children were killed, and another child fatally injured. The heavy sills of a bridge near us were picked up and driven into the ground from four to six feet. Ducks, prairie-chickens, and all kind of birds were found skinned as for a pot-pie. Our outfit is totally destroyed; the tents level, the transit, flags, grips and clothing are all gone. The wind tore the harness off the horses into shreds. One of the most valuable horses was killed and another badly crippled."

WIND-PRESSURE ON WINDOWS.

IN speaking of a severe gale that swept over England last month, the *Building News* says:

Not a few disasters were due to windows and shop-fronts having been blown clean inwards. In one case in the city a front was blown in, to the danger of those in the shop, and several similar accidents have been recorded. It is quite evident that builders and shop-front fitters neglect to look after the secure fixing of their wood frames and plate-glass. Happily, wind does not often blow directly against a shop-front, or many large sheets of plate-glass would be blown in at the risk of those near. At least the fact of two or three fronts having been blown in, points to the necessity of fixing laterally by iron-work, and not merely blocking up the frames of such windows, and of making the rebates in the bars deep enough to take the glass, and to allow of a fillet to be screwed on. The bars or mullions themselves are generally much too small in section to resist a cross strain; and there, also, some care should be taken. A light cast-iron stanchion, placed edgewise and perforated, is almost a necessity in lofty fronts, and these ought to be well fixed to the bressumer, and, indeed, might be made to render it some support. Casements are also dangerous, and householders ought to see that they are securely hung, and admit of secure fastenings; guttering, zinc-work, and finials need also constant attention, repair, and painting, if they are not to become dangerous appendages in time of strong winds. The rules for calculating the effects of wind upon structures are simple, and, if not well known, can be acquired by reference to any good text-book. It is hardly necessary, to inform the reader that the whole surface of a flat wall is exposed to a pressure equal to the extreme wind-force multiplied by the number of square feet the wall contains, and that the greatest effect of that accumulated pressure acts at a point near its geometrical centre. When this has been obtained, it will be seen how powerful a force is brought to bear against a building, or its weakest points, which, if they were not stiffened by floors and other means, would be enough to blow in or destroy many walls which are still standing. An ordinary window is exposed to a pressure of about 1,500 pounds, under such a wind as we had the other day, and this pressure acts in its centre. Can we wonder when we hear of innumerable windows having been blown in? Rotten or insecure beads give way, or the whole frame loosened from the brickwork by constant shaking, or through decay or shrinkage, is blown inwards.

WIND-PRESSURES ON ENGINEERING STRUCTURES.

The committee appointed by the British Board of Trade to consider the question of wind-pressures on railway structures, have submitted a report, from which we quote as follows:

It was necessary, in the first instance, to ascertain as accurately as possible from the sources which were accessible to us what the highest pressures of wind in this country [Great Britain] amount to. With this object we obtained from those observatories and stations where the pressure or velocity of the wind is measured the statements which we give in the appendix. In order to exhibit the action of the wind during heavy storms, we have also appended lithographed copies of wind diagrams taken by means of self-registering apparatus at Bidston, Glasgow, and Greenwich. At some of the stations from which we have obtained returns the wind-pressures are measured directly by Osler's self-registering pressure anemometers; at others the velocity only of the wind is measured by Robinson's rotating anemometers, the velocity of the wind being taken at three times the velocity of the revolving cups. For some stations the only published information is the run in miles of the wind during each hour. There can obviously be no more than a general accordance between this and the greatest pressure experienced during the hour. To utilize for our purpose observations taken at stations where the velocity of the wind only is recorded, the records of the Bidston Observatory, where both elements are recorded, have been employed as furnishing a means of connection between the two. In the case of high winds, with which alone we have to deal, it was found that the pressure recorded in an hour was tolerably well proportioned to the square of the mean velocity during the hour, and that the empirical formula $\frac{V^2}{100} = P$, where $V =$ maximum run in miles of the wind in any one hour, and $P =$ maximum pressure in pounds on the square foot at any time during the storm to which V refers, represented very fairly the greatest pressure as deduced from the mean velocity for an hour. We have accordingly given in the appendix a table, calculated from the above formula, for deducing maximum pressures from observed velocities. In addition to the tables obtained from English, Irish, and Scottish stations, which are those only that are strictly applicable to our inquiry, we give, as matter of information, a summary of strong winds registered at stations on the Continent and in India.

It will be seen on reference to the tables that the wind-pressures vary greatly at different stations. This, no doubt, mainly arises from difference of exposure of the stations to the action of the wind in consequence of the geographical and local circumstances of their position, but may in some cases be partly caused by differences in the instruments used for measurement. Thus, at Glasgow the highest recorded pressure per square foot is 47 pounds, while at Bidston, near Liverpool, the indicated pressure on one occasion amounted to 90 pounds, and on another occasion to 80 pounds. But the pressures at Bidston seem very abnormal, being much beyond what have been noticed at any of the other stations. The conformation of the ground on which the Bidston Observatory stands is such that the velocity of the wind there might be greatly intensified. It will be noticed in the lithographs that the records of exceptionally high pressures indicate a very brief duration. From inquiries we have made, we are satisfied that these records are not referable to instrumental error, depending on the recording instrument being carried by its momentum beyond the position of equilibrium under the wind-pressure acting at the moment, but represent a real phenomenon. But whether the exceptionally high velocities to which such pressures are due extend over a considerable space in a lateral direction, or, on the other hand, are extremey local, is a point on which we have not been able to find experimental evidence.

The differences of the wind-pressures observed at different stations led us to consider whether there were any other modes of approximately ascertaining the force of the wind for our purpose. There are many buildings, tall chimneys, ship-building sheds, etc., which probably would not withstand pressures so extreme as those we refer to; but in most cases the contour of the adjoining ground, and the obstruction to wind by adjoining buildings, trees and other surrounding objects, would render conclusions drawn from such cases unreliable. It occurred, however, to us that some useful information might be drawn from another source, viz., from railways themselves. It is obvious that on existing railways that have been long in use, a series of experiments, if we may apply such an expression to them, have for many years been carried on, for over them trains have been running at all times of the day and night on high and unsheltered embankments and along other spaces exposed in many cases to very strong winds. Now, a wind-pressure varying from 30 pounds to 40 pounds per square foot is sufficient to overturn the ordinary railway carriages that have been in use during the last twenty-five or thirty years, and we thought it useful to inquire from the different railway companies for cases where railway carriages have been overturned by the force of the wind. The only cases of this kind that have been brought to our knowledge are appended to this report.

From the information thus acquired, from the inquiries we have made, and from the consideration we have given to the subject, we are of opinion that the following rules will sufficiently meet the cases referred to us:

1. That for railway bridges and viaducts a maximum wind-pressure of 56 pounds per square foot should be assumed for the purpose of calculation.

2. That where the bridge or viaduct is formed of close girders, and the tops of such girders are as high or higher than the top of a train passing over the bridge, the total wind-pressure upon such bridge or viaduct should be ascertained by applying the full pressure of 56 pounds per square foot to the entire vertical surface of one main girder only. But if the top of a train passing over the bridge is higher than the tops of the main girders, the total wind-pressure upon such bridge or viaduct should be ascertained by applying the full pressure of 56 pounds per square foot to the entire vertical surface from the bottom of the main girders to the top of the train passing over the bridge.

3. That where the bridge or viaduct is of the lattice form, or of open construction, the wind-pressure upon the outer or windward girder should be ascertained by applying the full pressure of 56 pounds per square foot, as if the girder was a close girder, from the level of the rails to the top of a passing train over such bridge or viaduct, and by applying, in addition, the full pressure of 56 pounds per square foot at the ascertained vertical area of surface of the iron-work of the same girder situated below the level of the rails, or above the top of a train passing over such bridge or viaduct. The wind-pressure upon the inner or leeward girder or girders should be ascertained by applying a pressure per square foot to the ascertained vertical area of surface of the iron-work of one girder only situated below the level of the rails or above the top of a train passing over the said bridge or viaduct, according to the following scale, viz.: (*a*) If the surface area of the open spaces does not exceed two-thirds of the whole area included within the outline of the girder, the pressure should be taken at 28 pounds per square foot; (*b*) if the surface area of the open spaces lie between two-thirds and three-fourths of the whole area included within the outline of the girder, the pressure should be taken at 42 pounds per square foot; (*c*) if the surface area of the open spaces be greater than three-fourths of the whole area included within the outline of the girder, the pressure should be taken at the full pressure of 56 pounds per square foot.

4. That the pressure upon arches and the piers of bridges and viaducts should be ascertained as nearly as possible in conformity with the rules above stated.

5. That in order to insure a proper margin of safety for bridges and viaducts in respect of the strains caused by wind-pressure, they should be made of sufficient strength to withstand a strain of four times the amount due to the pressure calculated by the foregoing rules. And that, for cases where the tendency of the wind to overturn structures is counteracted by gravity alone, a factor of safety of two will be sufficient.

With regard to the eighth paragraph of the report of the Select Committee on the North British (Tay Bridge) Bill, to which you have drawn our attention, we beg to observe that where trains run between girders they will generally be sufficiently protected from the wind, the degree of protection afforded by the girders depending on the extent to which the girders are open or close; where the girders are so open as to afford insufficient protection, or where trains run, as in some cases they may do, on the tops of girders, we assume that the engineer will provide a sufficient parapet, but we are indisposed to go further into details on this subject, as it might tend to stereotype modes of construction, which we think is undesirable.

In conclusion, we beg to point out that the velocity of wind, like that of every other moving body, is more or less retarded by friction, and will be affected, therefore, by the character of the surfaces over which it has to pass, which may be rough, smooth, or irregular. It will follow, therefore, that, other things being the same, greater velocities will be attained at high altitudes than at low ones, the wind at high altitudes being further removed from retardation by friction. Though we are of opinion that no bridge or viaduct is likely to be built in such a situation as to expose it to wind-pressure equal to those which have been occasionally indicated by the disk on the Bidstone Observatory, yet, even if that were possible, a bridge or viaduct constructed according to the rules we have given would not be subjected to strains nearly equal to its theoretical strength. On the other hand, there will be many structures of small altitude or in sheltered situations which never can be exposed to the wind-pressure we have assumed, and where the application of the rules we have given would require modification. Some modification of the rules may also be required in the case of suspension or other bridges of very large span, but such cases will be of rare occurrence, and we recommend that they should be specially considered when they arise. We have the honor to be, sir,

Your most obedient servants,

John Hawkshaw,
W. G. Armstrong,
W. H. Barlow,
G. G. Stokes,
W. Yolland.

We, the undersigned, concur in the above report so far as it goes, but we think the following clause should be added, viz.:

The evidence before us does not enable us to judge as to the lateral extent of the extremely high pressures occasionally recorded by anemometers, and we think it desirable that experiments should be made to determine this question. If the lateral extent of exceptionally heavy gusts should prove to be very small, it would become a

question whether some relaxation might not be permitted in the requirements of this report. W. G. ARMSTRONG,
G. G. STOKES.

A DISCUSSION ON WIND-PRESSURE.

AT the Jubilee Meeting of the British Association, held at York during the past summer, Mr. Hawksley read a paper on this subject. He stated with regard to the phenomenon called "a gust of wind" nothing is known, either as to its cause or as to its exceptional but almost momentary velocity, or as to the extent of the area over which it temporarily operates; but it is, notwithstanding, certain that a wind-pressure of even forty pounds on the square foot is unknown in these islands, because, as may be readily shown, the intensity of pressure would suffice to have overthrown most of the long-existing factory chimneys, to have overset wind-mills, and to have scattered the greater number of the slighter-built domestic and other structures which have nevertheless "weathered many a storm," and still remain intact. It remains to make a passing allusion to whirlwinds, tornadoes, and waterspouts, all the results of spiral motions, apparently produced in some obscure manner by electrical action. These phenomena are very rarely observed to occur on an important scale in these kingdoms. The powerful forces concerned in or generated by these erratic movements have never been measured, and consequently cannot be formulated; but it may be observed that were they known they could not be introduced with propriety into calculations of the strength of structures intended to have a commercial value, because of the extreme improbability of any particular structure falling within the range of their destructive effects. They fall, in fact, within the legal category of "*Actus Dei.*" The conclusion of the author of this paper, therefore, is that for structural calculations a maximum wind-pressure of forty pounds per square foot may be very safely adopted, notwithstanding some common anemometrical observations to the contrary. With regard to these observations the author remarks that the instruments in use are little better than philosophical toys, and that, in general, they afford no direct, comparable, or reliable indications of either velocities or pressures; and that they are often so injudiciously placed as in many cases to record the effects of combined and therefore locally accelerated currents; whilst, in other instances they record only the effects of obstructed and therefore locally extended currents. As the acquisition of accurate data is of great and increasing importance, the author suggests that the British Association and other learned societies interested in physical investigations should unite in providing the necessary funds and observers for the purpose.

Mr. Symonds, President of the Meteorological Society, said the paper made no reference to the report of the Treasury Committee appointed to inquire into the Tay Bridge disaster, which would require a careful investigation before it could be accepted. Referring to the statement in the paper that whirlwinds were rarely observed on an important scale in these kingdoms, Mr. Symonds said that within the last month there had been no less than four seriously destructive whirlwinds in different parts of the country. The first in point of violence occurred at Boston, in Lincolnshire, taking a path a quarter of a mile long, and, irrespective of slight damage, seriously injured a carpenter's shed, carried a pile of timber into an adjoining field, went across a large drain, sucking the water up a foot and a half, went over a carpenter's shop eight feet high and ten feet square, lifting it bodily over a haystack and depositing it on the other side, went next to a foundry, the roof of which it deposited in a gentleman's drawing-room. There had also been a serious whirlwind at Braham Park, the effects of which he had not yet investigated. He understood that one of the large railway stations of Vienna had had its roof lifted off and carried away. It had long been his fear that the roofs of Charing Cross or King's Cross would be carried away and dropped down in some inconvenient position not intended for it. He could give many instances of mechanical energy by these storms, and of such a character, too, that they might think him romancing if he were to relate them. At Baldock the roofs of three maltings were carried away and deposited at a short distance from the maltings, but a few of the slates were found sticking in the trees. That would give them an idea of the energy of the wind. The Wind-pressure Commission had ignored entirely the question of whirlwind. If they had had a whirlwind of two hundred or three hundred feet in breadth, which had struck against the Tay Bridge, they would have the explanation of its downfall. The author's conclusion was that for structural calculations a maximum wind-pressure of forty pounds per square foot might be very safely adopted. If they were going to make their structures so strong that even a whirlwind would not carry them away, he was afraid their cost would be vastly increased.

Mr. Bateman said that when the railway bridge was made across the Menai Straits, he went through the calculations of wind-pressure with the late Sir William Fairbairn, and the maximum wind-pressure was one hundred and twenty pounds per square foot, upon which he believed the bridge was constructed. The actual pressure aimed at was what it might have to bear from a West Indian hurricane.

Mr. Head noticed that Mr. Hawksley assumed that the wind was perpendicular and always to the plane, and that it had a free escape all round.

Sir F. Bramwell: Mr. Hawksley provides for those cases where they are not.

Mr. Head only wished to say that that seemed to be very seldom the case in practice. The author also appeared to put out of question the wind coming in gusts. But he believed on the night of the Tay Bridge disaster one of the great features was the extremely violent gusts which occurred. If gusts could occur in that way, and as air had weight, might it not be that momentum was involved as well as pressure? Therefore the calculations of merely so much surface operated upon by so much pressure were not sufficient. Then, again, the great danger was in heavy gusts on surfaces which were boxed in. They ought to make experiments on the effect of wind on different shapes, such as square, convex, concave, and other kinds of surfaces. Those things would have to be taken into account before they could know something permanently useful about wind-pressure.

Mr. Symonds said that Mr. Hawksley went too far in speaking of the instruments used for the observation of wind-pressure as little better than toys; because if they were toys, they were the best in the world at the present time.

Sir F. Bramwell, in proposing a vote of thanks to Mr. Hawksley, said that the practical question for engineers was whether it was worth while to build structures so as to resist a hurricane, or must they be content to make them of sufficient strength to resist even extraordinary storms? It seemed to him that if the matter were investigated, the excessive extra cost of structures to resist hurricanes would be prohibitory. He stated the other day, on the authority of Mr. Barlow, that in the proposed Forth Bridge there were two thousand tons more material in consequence of its being made to resist the pressure produced by known or anticipated winds; and if they added to that material for resisting hurricanes, the bridge would not only become too costly, but an impossibility.

NOTES AND CLIPPINGS.

ANCIENT ROMAN SEWER. — A companion has lately been discovered, according to the *Daily News*, to the chief monument of Rome's regal period, the Cloaca Maxima. This drain starts from the Piazza Paganica, and passing under the Ghetto or Roman Jewry, discharges into the Tiber, opposite the island of San Bartommeo. It is built of blocks of Gabii stone. The walls, 1.80 metres high, are formed of blocks, each 0.90 metre high, 0.70 metre deep, and 2.50 metres long. The vault consists of five wedges, fitted together without cement. The bottom is paved. In several points restorations are visible, dating apparently from the sixteenth or seventeenth century.

WHITEWOOD DIMENSION. — A reader of the *Northwestern Lumberman* asks if whitewood is used for dimension, and if so, where. There is a great deal of whitewood dimension used in regions where whitewood grows. For framing purposes it is considered with much favor. If durable, however, it must be governed by certain conditions. It should be so placed that air will circulate freely around it, and it should be kept dry. If wet it quickly rots, and if kept from the air it loses its life and crumbles into dust. To place it between the walls of houses that are solid and tight would not be advisable, but for out-buildings that set up clear from the ground it answers admirably. We are not aware that it is often used outside of whitewood regions, but considering its worth, and the price at which it can be obtained, we do not see why it would not bear limited transportation.

REDWOOD. — A California writer says that the redwood which is in demand there for underground use is what is known by the lumbermen as black-heart redwood. It shows a dark color when cut with a knife, the outer layer only becoming seasoned. This species of redwood is exceedingly heavy; too heavy to float. One who has observed schooners loading at chutes along the coast assures the writer that a post of this wood which plunges overboard never rises, and a board lingers on the surface a moment and then slowly slides down into the depths. This is the sort which is sought for in the foundation of buildings, and under brick walls is believed to be imperishable. In this connection it is interesting to mention a fact concerning the second growth of redwood. Shoots from old stumps have grown to be three and four feet in diameter in forty years. This would indicate restorative powers in redwood forests, which would insure a future supply of the timber. — *Northwestern Lumberman.*

A CAVE IN THE BALEARIC ISLES. — Under the heading, "A Mysterious Grotto," some of the French papers are relating the following story, which appears to be received with credence, despite the numbers of similar but mythical tales that have from time to time been circulated. Several sportsmen in pursuit of game in Formentera, one of the Balearic Islands, suddenly came upon a deep excavation, the entrance to which was covered with bushes and undergrowth. They proceeded to explore it, and having with some difficulty removed several large stones found themselves in a well-built chamber of Moorish design, the walls of which were ornamented with undecipherable characters. In the middle of the chamber were two tombs of admirable workmanship. On removing the metal covers by which they were closed the explorers discovered two colossal mummified bodies, one on the right being that of a young woman, the other that of a man. On the head of the woman was a diadem set with stones which, if genuine, are of inestimable value. Around her neck was a necklace of large pearls, two enormous ear-rings were attached to her ears, and her fingers were covered with rings. On the head of the man was an imperial crown, and in his right hand he held a sceptre. Six of the discoverers remained to guard the treasure, and the others left for Madrid to consult the authorities. The inhabitants are said to have known of the cavern, but had never entered it, thinking it was only a resort of serpents. — *New York Tribune.*

BUILDING INTELLIGENCE.

(Reported for The American Architect and Building News.)

[*Although a large portion of the building intelligence is provided by their regular correspondents, the editors greatly desire to receive voluntary information, especially from the smaller and outlying towns.*]

BUILDING PATENTS.

[*Printed specifications of any patents here mentioned, together with full detail illustrations, may be obtained of the Commissioner of Patents, at Washington, for twenty-five cents.*]

249,171. AUTOMATIC FIRE-EXTINGUISHER. — Frederick Grinnell, Providence, R. I.
249,172. PIPE-FITTING. — Frederick Grinnell, Providence, R. I.
249,209. SASH-FASTENER. — Charles E. Steller, Milwaukee, Wis.
249,215. SOLDERING-COPPER. — Samuel Woodhead, West Troy, N. Y.
249,229. SOLDERING-IMPLEMENT. — John Doyle, Hoboken, N. J.
249,236. FIRE-EXTINGUISHER. — Charles L. Garfield, Albany, N. Y.
249,239. ASBESTOS ROOF PAINT OR COMPOSITION. — Frederick M. Hibbard, Goshen, Ind.
249,250. FASTENER FOR MEETING-RAILS OF SASHES. — Thomas R. Miller, New Haven, Conn.
249,253. DOOR-SPRING. — Patrick K. O'Lally, Boston, Mass.
249,260. SEWER-TRAP. — Alexander and Ralph Robb, Brooklyn, N. Y.
249,304. LOCK-HINGE. — Charles B. Clark, Detroit, Mich.
249,306. MORTISING-MACHINE. — Frank S. Clarkson, Baltimore, Md.
249,308. CHIMNEY. — Leonard E. Clawson, San Francisco, Cal.
249,315. EXPANSIBLE WEDGE FOR OPENING SAW-KERFS. — Coulder C. Dedermick, Fowler, Mich.
249,325. ELEVATOR. — David Edwards, Cardiff, County of Glamorgan, Wales.
249,339. FILTER. — Almon M. Granger, Boston, Mass.
249,364. REVERSIBLE SPRING-HINGE. — George M. Jewett, Unionville, Conn.
249,391. WATER-CLOSET. — Michael J. O'Rielley, Buffalo, N. Y.
249,394. PIPE-WRENCH. — Isaac B. Potte, Columbus, Ohio.
249,397. INVERT-BLOCK FOR SEWERS. — Gustavus W. Rader, New York, N. Y.
249,400. STREET-CURB. — Wm. Reddall, 10 South St., Finsbury, England.
249,416. FIRE-LADDER. — Samuel M. Stewart, Rochester, N. Y.
249,428-429. MANUFACTURE OF PANELS, SLABS, AND OTHER ARTICLES FROM OXIDIZED OIL. — Frederick Walton, Heatham House, Twickenham, County of Middlesex, England.
249,430. BURGLAR-ALARM. — Hiram H. Ward, Packwaukee, Wis.

SUMMARY OF THE WEEK.

Baltimore.

BUILDING PERMITS. — Since our last report fifteen permits have been granted, of which the following are the more important: —

Louisa Hoffman, three-st'y brick building, No. 188 Orleans St., near Bond St.

K. C. Just and Wm. Weigel, 7 two-st'y brick buildings, 6 on St. Peters St., commencing on Sterrett St., 1 on Sterrett St., in rear of the above.

C. W. Boruman, three-st'y brick building, 14' x 36', Decker St., between Federal St. and Jones' Falls.

J. Casey Barry, 3 three-st'y brick buildings, 15' 8" x 49' each, Division St., between Wilson and McMechin Sts.

J. Casey Barry, 4 two-st'y brick buildings, 12' x 38' each, Etting St., between Wilson and McMechin Sts.

Brown Memorial Church, three-st'y brick parsonage, Park Ave., adjoining the church.

WAREHOUSE. — Mr. Henry Whyte is having erected a four-st'y brick and stone warehouse 27' x 130', on Frederick St., between Baltimore and Second Sts.; cost, $17,000; Mr. Wm. Ferguson, contractor, Mr. Chas. L. Carson, architect.

BANK BUILDING. — Mr. Chas. L. Carson is preparing drawings for the Traders' National Bank, to be built on German St., near Mercer St., the building will be 22' 6" x 74' 6," constructed of brick, stone and terra-cotta, will have three stories and a basement; and cost about $20,000.

CARRIAGE-HOUSE. — Messrs. Denny and Mitchell are about to erect a three-st'y carriage-house on the lot, 815 West Baltimore St., between Carey and Republican Sts. The building will be 30' x 155', faced with pressed brick and stone, and cost about $12,000; Mr. John Walters, superintendent; Mr. George Archer, architect.

CHAPEL. — Mr. Geo. Archer, architect, has prepared drawings for the Abbott Chapel, (Presbyterian), Highland Avenue, Baltimore. The edifice will be 44' x 100', built of pressed brick and stone, and cost about $15,000.

CHURCH. — The corner-stone of the new building of Epworth Independent Methodist Church, cor. of Gilmor and Mosher Sts., was laid Thursday afternoon, Nov. 10. The structure will be in the Norman Gothic style. It will have a frontage of 64' 2" a depth of 103', and will be 40' high. The south-west corner will have a lofty tower and steeple. The basement will be built of local bluestone, with granite finish; the upper part of the building will be of brick, with red sandstone finish. The church will have seating capacity for 700 persons; cost, $40,000; Messrs. W. T. Markland and Bro., builders; Mr. Chas. L. Carson, architect.

Boston.

BUILDING PERMITS. — *Wood.* — *Walnut Park*, near Walnut Ave., for W. D. Cotton, dwell., 46' x 46', ell, 15' x 32', two-st'y; Andrew Anderson, builder.

Alban St., rear of, near Ashmont St., for Frank Wood, stable, 26' x 41', two-st'y; John F. Haines, builder.

East Fourth St., No. 864, for Hannah C. O'Neil, slipper manufactory, 18' x 40'; J. F. Tighe, builder.

Monadnock St., near Dudley St., for Geo. W. Smith, 2 dwells., 30' x 38', two st'y; John Horsfield, builder.

Adams St., near Milton St., for Mrs. Harriet M. James, dwell., 24' x 33', ell 18' x 20', two-st'y hip; Henry P. Oakman, builder.

Ashmont St., near Alban St., for Franklin King, dwell., 26' 6" x 30", two-st'y; W. J. Jobbing, builder.

Forest Hill Ave., rear of, near Sanford St., for Nathan S. Clark, storage, 18' x 18' 8"; Fred. M. Severance, builder.

Washington St., rear of, near Codman Ave., storehouse, 21' x 28', for City of Boston.

Gates St., for Lyman Lock, dwell., 26' 4" x 46' 4", three-st'y; Lyman Lock, builder.

Spring Park Ave., near A St., for Geo. M. Harding, dwell., 23' x 36', two-st'y.

Waverley St., cor. Western Ave., for Old Engine-house S. S. So., church, 38' x 43'; Kelly & McKinnon, builder.

Farnham St., rear of, near Gerard St., storage, 40' x 50', for G. W. & F. Smith Iron Co.

Allston St., cor. Sharp St., for A. W. Tice, dwell., 34' x 35'; Chas. Stinson & Co., builders.

Waverley St., near Market St., for Roderick Richardson, 2 dwells., 15' x 44', two-st'y; Stephen Ellis, builder.

Lamartine St., opposite Spring Lane, for Martha Nelson, 2 dwells., 22' x 30', two-st'y; D. G. Drew, builder.

Heath Pl., rear of, for Frank Hubner, stable, 16' x 24', two-st'y; F. A. Schell, builder.

Parkman St., near Dorchester Ave., for Mrs. Hiram Batchelder, dwell., 29' x 30', two-st'y, and dwell., 29' x 38', two-st'y; Mead, Mason & Co., builders.

Island St., near Magazine St., for Masten & Wells, for manufacture of fireworks, 32' x 40', two-st'y; Wm. Morse, builder;

Seaverns Ave., near Alfred St., for D. S. Smalley, 2 dwells., 21' x 38', two-st'y; Joseph Hammerle, builder.

Alfred St., near Chestnut St., for Caroline E. Skinner, 2 dwells., 20' x 32', and dwell., 23' x 32', three-st'y; John D. Wester, builder.

Savin St., near Warren St., for Jos. F. Pray, 23' x 49', two-st'y; Henry J. Bartlett, builder.

Trull St., near Hancock St., for Franklin King, dwell., 28' 6" x 29', two-st'y mansard; Edw. McKechnie, builder.

Brick. — *A St.*, rear of, for N. Y. & N. E. R. R. Co., sand-house, 22' x 44', two-st'y; H. H. Graham, builder.

Unnamed Pl., off Union Ave., for Benj. F. Sturtevant, foundry, 78' and 102' 6' x 160', ell, 39' x 58' 8"; Cyprus W. Cole, builder.

Marlboro' St., near Exeter St., for Josiah Bradlee, dwell., 30' x 57', four-st'y mansard; Vinal & Dodge, contractors.

Commonwealth Ave., near Hereford St., for Frank N. Thayer, 25' 7" x 60', three-st'y; J. W. Tobey, builder.

Bedford St., Nos. 72-78, for Rob. Barnard and J. J. Richards, mercantile, 22' 6" and 78' x 71' 6" and 109' 6", two-st'y; Fessenden & Libby, builders.

Armory St., rear of, near Codman Ave., mechanical; C. G. Burgess & E. H. Perry, 28' x 100', three-st'y; Marshall Livermore, builder.

Brooklyn.

BUILDING PERMITS. — *Hooper St.*, s s, about 150' w Harrison Ave., 2 two-and-a-half-st'y stone dwells.; cost, $12,000; owner and builder, John McQuade; architect, W. H. Gaylor.

Central Ave., w s, 50' s Troutman St., 2 three-st'y frame tenements; cost, $4,000 each; owner, Mr. Singer, Troutman St., near Central Ave.; builders, Mr. Platz and J. Rueger.

Greene Ave., n s, 100' w Nostrand Ave., 5 three-st'y brownstone dwells.; cost, $7,000 each; owner, Spencer Aldrich, 260 Broadway, New York; architect and builder, Wm. J. Rider.

Greene Ave., s w cor. Nostrand Ave., 5 three-st'y brownstone dwells.; cost, $7,000 each; owner, Chas. M. Marsh, 481 Washington Ave.; architect and builder, Wm. J. Rider.

Henry St., s w cor. President St., four-st'y brownstone flat and store; cost, $10,000; owner, E. L. Donnellon, President St., near Henry St.; architect, R. Dixon; builder, W. C. Donnellon.

South Elliott Pl., w s, 90' s Hanson Pl., three-st'y brownstone dwell.; cost, $8,000; owner, Mary Magilligan, 30 St. Marks Ave.; builder, John Magilligan.

Jackson St., s s, 150 e Ewen St., four-st'y brick factory; cost, $7,000; owner, Valentine & Co., 323 Pearl St., New York; architect, E. E. Raht; builders, J. D. Anderson and John Lee.

Washington Ave., Nos. 425 *and* 427, between Greene and Gates Aves., 2 three-and-a-half-st'y brownstone dwells.; cost, $14,000; owner, etc., D. H. Fowler, 14 Vernon Pl.; architect, A. Hill; builder, T. Baker.

Berkley Pl., n s, 90' e Seventh Ave., three-st'y stone dwell., cost, $10,000; owner, etc., Wm. Flanagan, 355 Ninth St.

Hoyt St., w s, 74' 10" s Carroll St., two-st'y brick stable; cost, $2,500; owner, James Chase, 284 President St.; architect, Stanley S. Covert.

North Third St., Nos. 91 *to* 97, five-st'y brick copper shop; cost, $35,000; owner, Paul Weidmann, 93 South Ninth St.; architect, A. Herbert.

Tompkins Ave., No. 378, w s, 60' s Putnam Ave., three-st'y brick flat; cost, $5,000; owner, Samuel Hanna, De Kalb Ave., near Marcy Ave.; architect, R. Van Brunt; builder, Wm. H. Burhaus.

ALTERATIONS. — *Fulton St. No.* 279, repair damage by fire; cost, $2,500; owner, —— Plato; architect and builder, John Rea.

Bergen St., Nos. 20 *and* 22, two-st'y brick extension; cost, $2,000; owner, Estate D. K. Ducker, Fulton St.; architect, Wm. Taylor; builders, Peter Kelly & Son and R. F. Whipple.

Chicago.

BUILDING PERMITS. — Washington Ice Co., two-st'y brick ice-house, 30' x 69', 379 Thirty-first St.; cost, $3,000.

Albert Albrecht, one-st'y brick cottage, 20' x 34', 733 North Ashland Ave.; cost, $950.

G. A. Wrisley, additional st'y on soap factory, 30' x 50', Kingsbury and Superior Sts.; cost, $2,500.

Robert Falk, one st'y brick store front addition, 678 Thirty-first St., 22' x 34'; cost, $1,000.

P. O. Lundstrom, 2 two-st'y and basement brick dwells., 43' x 56', 325 and 327 Mohawk St.; cost, $8,000.

Sarah Woods, basement, 21' x 37', 165 Henry St.; cost, $700.

Chas. Segers, two-st'y and basement brick dwell., 27 Mohawk St.; cost, $1,800.

C. Schaefer, one-st'y brick additional story, 20' x 40', Hurlbut St., near North Ave.; cost, $500.

Geo. Serek, one st'y brick cottage, 20' x 50', 217 Thirteenth St.; cost, $1,600.

J. Straube, one-st'y brick cottage, 20' x 28', Keely and Lyman Sts.; cost, $800.

James O'Connor, one st'y brick cottage, 18' x 22', Emerald Ave. and Twenty-ninth St.; cost, $600.

M. Shell, one-st'y brick cottage, 21' x 32', 2828 Dashiel St.; cost, $900.

M. S. Nichols, one-st'y brick addition, 25' x 60', Michigan Ave. and Twenty-eighth St.; cost, $3,000.

R. Smith, one-st'y brick cottage, 22' x 40', 153 Ashley St.; cost, $1,000.

John A. Seaman, two-st'y brick dry-room, 26' x 60', Hoyne and Ferdinand Sts.; cost, $2,000.

Charles Stafford, one-st'y brick cottage, 20' x 36', Butterfield and Twenty-second Sts; cost, $500.

George M. Clark, three-st'y and basement brick livery stable, 50' x 100', 331 and 333 North Clark St.; cost, $14,000.

A. Schermann, brick basement, 20' x 42', 79 West Division St.; cost, $800.

Hill & Co., one-st'y brick boiler-shop, 58' x 63', 341 and 343 Canal St.; cost, $1,500.

Aug. Hilm, one-st'y brick cottage, 20' x 32', 629 West Eighteenth St.; cost, $600.

Maxwell Bros., one-st'y brick, 38' x 100', Loomis and Hinman Sts.; cost, $1,000.

E. H. Castle, 2 one-st'y brick, 20' x 28', 12 Paulina St.; cost, $500.

M. Meysheider, brick basement, 20' x 100', 149 North Ave.; cost, $700.

C. J. Adams, 2 one-st'y brick cottages, 20' x 30', Main St., near Thirty-first St.; cost, $1,600.

A. C. Ellithorpe, brick basement, 23' x 40', 52 Morgan St.; cost, $500.

Estate of Daniel Weaver, three-st'y brick dwell., 26' x 60', Eldridge Court, near State St.; cost, $6,000.

New York.

BUILDING PERMITS. — *Ninetieth St.*, s s, 82' e Park Ave., 3 four-st'y brownstone tenements; cost, each, $30,000 and $18,000; owner and architect, S. Murphy, 156 East Sixty-fifth St.

Lexington Ave., n e cor. Fortieth St., three-st'y brick hospital; cost, $18,000; owner, Nursery and Child's Hospital, on premises; architects, Thom & Wilson; builders, Sinclair & Mill and Guy Culgin.

Seventh Ave., n e cor Fifty-fifth St., brick building with three wings, two-st'y in height; cost, $50,000; owner, New York Panorama Co.; architects, D. Jlennan and F. Renwick; builders, E. D. Connolly & Son.

Fifty-seventh St., n s, 292' w Sixth Ave., one stone foundation only for a church; cost, $10,000; owner, Calvary Baptist Church; architect, J. R. Thomas.

One Hundred and Twenty-fifth St., n s, 100' w Ninth Ave., 3 four-st'y brick apartment-houses; cost, each, $12,000; owner, Catharine Fettretch, 111 West One Hundred and Twenty-fourth St.; architect, D. J. MacRae.

One Hundred and Twenty-fifth St, n s, 400' e Eighth Ave., 2 four-st'y stone stores and tenements; cost, $15,000 and $30,000; owner, Helen M. Blaisdell, 48 East One Hundred and Twenty-fourth St.; architect, J. G. Prague.

One Hundred and Twenty-sixth St., s s, 400' e Eighth Ave., 2 four-st'y brick and stone apartment-houses; cost, each, $15,000 and $30,000; owner and architect, same as last.

One Hundred and Fifth St., n s, 200' w Ninth Ave. runs to One Hundred and Sixth St., three-st'y brick asylum; cost, $100,000; owner, Home for Aged and Infirm Hebrews, 710 East Fourteenth St.; architects, D. & J. Jardine.

One Hundred and Thirty-third St., n s, 100' w Lincoln Ave., two-st'y brick and iron moulding and planing mill; cost, $4,700; owner, John Davidson, Broadway Bank Building; architect, W. H. Walton, builder, Jno. Knox.

One Hundred and Twenty-third St., s s, 100' e Sixth Ave., 6 three-st'y brownstone dwells; cost, each, $12,000; owner, Samuel H. Bailey, 186 East One Hundred and Fourth St.; architect, Chas. Baxter.

Seventy-seventh St., n s, 375' e Second Ave., four-st'y brownstone tenement; cost, $9,000; owner, Patrick Keys, 352 East Seventy-eighth St.; architect, A. B. Ogden.

First Ave., s e cor. Seventy-ninth St., four-st'y brownstone store and apartment-house; cost, $20,000; owner, Mrs. Annie E. Kelly, 404 East Eighty-second St.; architect, J. C. Burne.

Seventy-ninth St., n s 325 e Third Ave., four-st'y brownstone apartment-house; cost, $19,000; owner, Mrs. Sarah T. McCool, 312 East Fifty-seventh St.; architect, J. C. Burne.

One Hundred and Thirty-seventh St., n e cor. College Ave., one-st'y brick factory; cost, $10,000; owner, J. L. Mott Iron Works, 2122 Fifth Ave.; architects, Babcock & McAvoy.

One Hundred and Tenth St., n s, 126' e Third Ave., 4 four-st'y Connecticut brownstone dwells.; cost, $14,000; owners, John Cullen and Michael Reilly, 207 East One Hundred and Sixth St.; architect, Chas. Baxter.

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