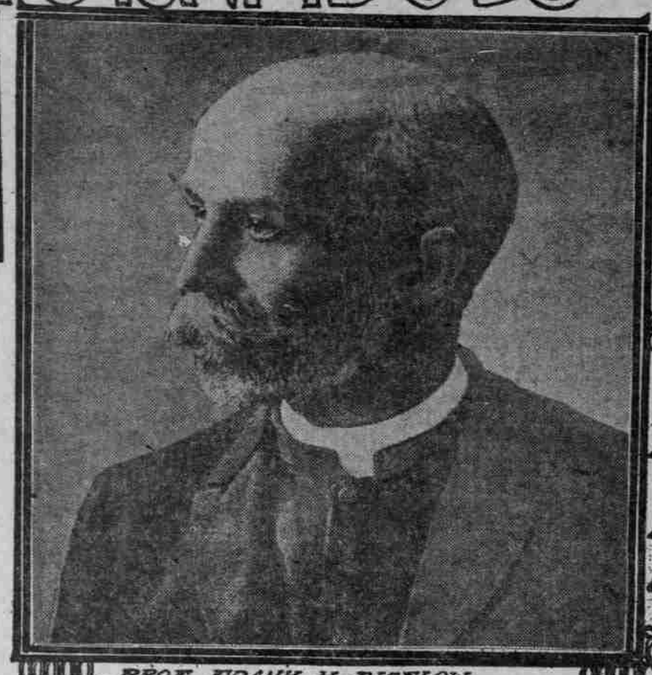
MEASURING TORNADOES and STUDYING their CAUSE

VELOCITY OF THE WORST ONES ELEVEN MILES A MINUTE; PRESSURE SO GREAT THAT NO BUILD--ING CAN RESIST IT.



PROF FRANK H. BIGELOW

IN THE TORNADO'S PATH. KIRKVILLE MO.

BY JOHN ELFRETH WATKINS.

THE weather bureau is just completing a new investigation of tornadoes which is developing some interesting facts. Since tornado season begins with Spring, this is an opportune time to tell you what is being found out about these most violent storms known to man.

The investigations are being made by Professor Frank H. Bigelow, of the weather bureau staff, and on the basis of these new observations he has formulated a new theory that refutes the old notion that tornadoes are due to the mechanical interference of air currents.

Twenty-five tornadoes devastate our territory per annum. This is the average frequency, and there seems to be no increase from decade to decade. You will probably be reading of the season's first visitation in a few weeks, or, perhaps, in a few days. Then they will increase in frequency during May and June and then commence to taper off in July. There are, however, a few Winter visitations in the Gulf States. When tornadoes appear the papers generally announce them as "cyclones," a result of our national hobby for misnomers, evidenced also in our calling the cicada a "locust" and the bison a "buffalo." As a matter of fact, cyclones are the general storms which sweep over our country from the North Pacific Coast and last for days at a time, whereas tornadoes develop suddenly within, perhaps, one township and generally last but a few minutes.

The tornado's vortex, or tube, is usually but a few rods in diameter, leaving a path of destruction but a few rods wide and a few miles long, whereas that of the cyclone is perhaps 1000 miles across, leaving little if any destruction in its path. The cyclone's funnel is a mile or two, but the tornado's funnel only a few hundred feet high.

Their Cause Discovered.

As to the cause of tornadoes, Professor Bigelow finds it due to a sheet of cold air lying over a sheet of warm air. Since heat ascends, these two sheets change places and develop currents of motion forming into the whirlwind seen in the tornado cloud.

He finds two types of these tornado vortices—the funnel and dumbbell form. We have heard only of the funnel type hitherto, have thought of the tornado as having always a funnel cloud or tube. Sometimes one of these forms changes into the other, as in the case of the waterspout seen off Cottage City, Mass., August 19. A waterspout, of course, is nothing more than a tornado appearing over the ocean, from which it sucks up water. That off Cottage City changed from the dumbbell to the funnel-shaped tube.

New System of Measuring Them.

For measuring a tornado or waterspout tube, Professor Bigelow has employed an ingenious method. Photographs having been made of them from two different angles, he can accurately compute the dimensions of the tube from these snapshots. After collecting the photographs he visits the spots where the cameras have stood and makes a survey of the distances between these spots and stationary objects of the landscape shown in the pictures. Thus, with his surveying instruments he gets his scale of distances. Then he plats the vortex on a map and gathers data from all of the weather records kept in the neighborhood. Finally, by aid of mathematics, he constructs a diagram of the funnel-shaped or dumbbell-shaped tube, and from this he estimates its volume and the velocity of its spiral air currents. Such a thorough study of tornadoes and waterspouts has never been made before. He is extending his method also to cyclones and hurricanes and thus these phenomena can be compared with the smaller and more furious storms.

First Glimpse at Awful Force.

Our first glimpse at the terrible force of tornadoes is to be had through his computations of the great Cottage City waterspout, which, as stated, appeared over two miles per minute faster than the neck of the funnel tube. The inner edge of this neck revolved 27 times as fast as the outer edge, and on the outer surface of the great dumb-bell the rotation was 27 times greater at the neck than on the expanded surface 295 feet above the neck. In this dumbbell form it sucked up nearly seven times as much air as when in the funnel form, or about $6,000 cubic yards per second.

The force of the great St. Louis tornado, which ravaged that city 12 years ago, has also been computed by Professor Bigelow, whose figures for that phenomenon are also just announced for the first time. He estimates that the innermost edge of the vortex neck of the St. Louis tornado—which had the dumbbell form—rotated at a speed of 787 feet per second, or nearly nine miles per minute, which was somewhat less than the velocity of the corresponding point in the Cottage City waterspout when in its dumb-bell form, yet somewhat greater than when the latter was in its funnel form. But the St. Louis tornado is found to have been nearly 50 times as efficient in lifting air as was the Cottage City waterspout when it also was in dumbbell form. Professor Bigelow tells me that all of these computations, of course, are mathematical, and based upon what the force of these phenomena would have been if their vortices were perfectly formed. Of course no photographic lens can penetrate to the interior of a tornado or waterspout tube, to show whether it was regular or irregular.

Large tornadoes, cyclones and hurricanes are constructed upon the same principles, differing only in dimensions and proportions, according to Professor Bigelow. They all develop at an upper plane and extend downward toward the surface of the earth, the lower portion of their vortices being destroyed in the working of their tubes against the land or sea.

Hurricanes are deep tornadoes of the simple dumb-bell shape, and cyclones are of this shape, in part, but the vortex is very imperfect. One hurricane which has been computed—the "De Witte typhoon"—in the China Sea, in August, 1901, was a great dumb-bell vortex. The part of its neck that showed the fastest rotation was some two miles higher than sea level, and therefore above buildings and ships. Here the wide vortex of wind revolved at a speed of about seven and a half miles per minute, which was less than the tornado velocities above mentioned. But the vastness of this dumb-bell can be better realized by Professor Bigelow's computation that it carried up nearly 100,000 times as much air as the Cottage City waterspout.

The Terrific Pressures.

It is beyond human power to build a structure, even of the strongest steel or masonry, which can withstand the tornado's full fury. The inner edge of the vortex of the Cottage City waterspout exerted a pressure up to about 1000 pounds per square foot at sea level, when it was in the funnel form; and it must have been more than a ton per square foot up in the fastest part of the neck when it was in the dumb-bell form. Structures built to withstand 40 pounds to the square foot are considered to be hurricane proof. But there is not a building on earth that could withstand the pressure in the eye of the vortex of the Cottage City waterspout or of any other tornado of its power.

The danger zone of a tornado is confined pretty closely to the path of the vortex, according to Professor Gigelow. In the northern hemisphere, which we inhabit, its violence is always greatest on the southern side of this path, but in the southern hemisphere—below the equator—the greatest fury is always on its northern edge. Another interesting fact is that all of these corkscrew vortices—those of tornadoes, hurricanes and cyclones—in the northern hemisphere invariably rotate in a direction opposite to that of the hands of a watch laid face up, while those of the southern hemisphere revolve in the same direction as the watch's hands.

Safety Hints.

The direction of the tornado path is usually from southwest to northeast. Hence when you see a vortex cloud in the southwest the chances are that it is coming your way. The signs of the tornado's approach are those of a thunder storm, but much exaggerated. The vortex cloud approaches with a roar like that of a hundred heavy railroad trains at top speed. Often the vortex cloud cannot be seen, however, even at midday. Intense thunder and lightning, a torrent of rain or hail frequently accompany or follow it.

To escape an approaching tornado persons in our hemisphere should run to the north or northwest of the evident path of the approaching vortex or take refuge in a cellar, preferably that of an ordinary frame house, where falling walls of brick or stone cannot crush them. The "cyclone cellars" scattered over our tornado belt have been the means of saving many hundreds of lives. These excavations are usually crowned by low mounds and superstructures of light framework like that of the icehouse cellar of an old-time country house.

The tornado is the most eccentric of our storms. One minute it will grind a stately building to dust and the next it will lift a locomotive from the rails, only to replace it uninjured hundreds of feet away, while at a further stage of its progress it will drive straws or bits of paper through the bark of trees without tearing them. The tornado of Kirkville, Mo., in 1899, lifted a piano out of one house, transported it 1000 feet through the air and then deposited it in the room of another dwelling.

Our Tornado Belt.

Sixty tornadoes in one day devastated part of eight of our states in 1884, our banner tornado year. Fully 800 people were killed, 2800 injured and 10,000 buildings were destroyed on that single date. But the most disastrous tornadoes of our history have been those of Louisville, in 1890, and St. Louis, in 1896. The former plowed a furrow 1000 feet wide through Kentuckys metropolis, destroying five churches, the union station, two halls, three schools, 266 stores, 32 factories, 10 warehouses and 832 residences. Seventy-six people were killed, 200 were injured and the loss was $2,150,000. In 1854 another tornado had plowed through Louisville, killing 25 people. The St. Louis visitation was the severest of our history, killing 500, injuring 1500 and destroying property worth $14,500,000.

Our "tornado belt," or region of greatest frequency, occupies the Mississippi and Ohio valleys, but Nebraska, South Dakota, Iowa and Minnesota are our tornado states par excellence. The Rocky Mountains plateau and slope are free from such visitations, but thence eastward to the Atlantic there are few states, if any, not occasionally visited. New England's cool climate has not rendered it immune. It was visited by destructive tornadoes in 1878 and 1890.

Washington, D. C., March 22.

A KANSAS "CYCLONE CELLAR"

A DUMBELL VORTEX

STORIES OF JESUS OF NAZARETH—HIS GREAT ADDRESS

NO. IV.

AND seeing the multitudes, he went up into the mountain; and when he had sat down, his disciples came unto him; and he opened his mouth and taught them, saying:

Steps in the Happy Way.

Blessed are the poor in spirit; for theirs is the kingdom of heaven.

Blessed are they that mourn; for they shall be comforted.

Blessed are the meek; for they shall inherit the earth.

Blessed are they that hunger and thirst after righteousness; for they shall be filled.

Blessed are the merciful; for they shall obtain mercy.

Blessed are the pure in heart; for they shall see God.

Blessed are the peacemakers; for they shall be called sons of God.

Blessed are they that have been persecuted for righteousness sake; for theirs is the kingdom of heaven. Blessed are ye when men shall reproach you, and persecute you, and say all manner of evil against you falsely, for my sake. Rejoice, and be exceeding glad; for great is your reward in heaven; for so persecuted they the prophets which were before you.

A Life for Earth.

Ye are the salt of the earth; but if the salt have lost its savor, wherewith shall it be salted? it is thenceforth good for nothing, but to be cast out and trodden under foot of men. Ye are the light of the world.

A city set on a hill cannot be hid. Neither do men light a lamp and put it under the bushel, but on the stand; and it shineth unto all that are in the house. Even so let your light shine before men, that they may see your godd works and glorify your Father which is in heaven.

Not Outside Righteousness.

Think not that I came to destroy the law or the prophets: I came not to destroy, but to fulfill. For verily I say unto you, Till heaven and earth pass away, one jot or one title shall in no wise pass away from the law till all things be accomplished. Whosoever therefore shall break one of these least commandments, and shall teach men so, shall be called least in the kingdom of heaven; but whosoever shall do and teach them, he shall be called great in the kingdom of heaven. For I say unto you, that except your righteousness shall exceed the righteousness of the scribes and Pharisees, ye shall in no wise enter into the kingdom of heaven.

HUMAN RELATIONS.

1. Be Not Angry.

Ye have heard that it was said of them of old time, Thou shalt not kill; and whosoever shall kill shall be in danger of the judgment; but I say unto you, that every one who is angry with his brother shall be in danger of the judgment; and whosoever shall say to his brother, Raca shall be in danger of the council; and whosoever shall say, Thou fool, shall be in danger of the hell of fire.

If therefore thou art offering thy gift at the altar, and there remembrest that thy brother hath aught against thee, leave there thy gift before the altar, and go thy way, first be reconciled to thy brother, and then came and offer thy gift.

Agree with thine adversary quickly, whiles thou art with him in the way; lest haply the adversary deliver thee to the judge and the judge deliver thee to the officer, and thou be cast into prison. Verily I say unto thee, Thou shalt by no means come out thence, till thou have paid the last farthing.

2. Be Pure.

Ye have heard that it was said, Thou shalt not commit adultery; but I say unto you, that every one that looketh on a woman to lust after her hath committed adultery with her already in his heart.

And if thy right eye causeth thee to stumble, pluck it out, and cast it from thee; for it is profitable for thee that one of thy members should perish, and not thy whole body be cast into hell. And if thy right hand causeth thee to stumble, cut it off, and cast it from thee; for it is profitable for thee that one of thy members should perish, and not thy whole body go into hell.

It was said also, Whosoever shall put away his wife, let him give her a writing of divorcement; but I say unto you, that every one that putteth away his wife, saving for the cause of fornication, maketh her an adulteress; and whosoever shall marry her when she is put away committeth adultery.

Again, ye have heard that it was said to them of old time, Thou shalt not forswear thyself, but shalt perform unto the Lord thine oaths; but I say unto you, Swear not at all; neither by the heaven, for it is the throne of God; nor by the earth, for it is the footstool of his feet; nor by Jerusalem, for it is the city of the great King. Neither shalt thou swear by thy head, for thou canst not make one hair white or black. But let your speech be, Yea, yea; Nay, nay; and whatsoever is more than these is of the evil one.

4. Resist Not Evil.

Ye have heard that it was said, An eye for an eye, and a tooth for a tooth; but I say unto you, Resist not him that is evil; but whosoever smiteth thee on thy right cheek, turn to him the other also. And if any man would go to law with thee, and take away thy coat, let him have thy cloak also. And whosoever shall compel thee to go one mile, go with him twain. Give to him that asketh thee, and from him that would borrow of thee turn not thou away.

5. Love Your Enemies.

Ye have heard that it was said, Thou shalt love thy neighbor, and hate thine enemy; but I say unto you, Love your enemies, and pray for them that persecute you; that ye may be sons of your Father which is in heaven: for he maketh his sun to rise on the evil and the good, and sendeth rain on the just and the unjust.

For if ye love them that love you, what reward have ye? do not even the publicans the same? And if ye salute thy brethren only, what do ye more than others? do not even the Gentiles the same? Ye therefore shall be perfect, as your heavenly Father is perfect.

DIVINE RELATIONS.

1. Give, Unto God.

Take heed that ye do not your righteousness before men, to be seen of them; else ye have no reward with your Father which is in heaven.

When therefore thou doest alms, sound not a trumpet before thee; as the hypocrites do in the synagogues and in the streets, that they may have glory of men. Verily I say unto you, they have received their reward. But when thou doest alms, let not thy left hand know what thy right hand doeth; that thine alms may be in secret; and thy Father which seeth in secret shall recompense thee.

And when ye pray, ye shall not be as the hypocrites; for they love to stand and pray in the synagogues and in the corners of the streets, that they may be seen of men. Verily I say unto you, They have received their reward. But thou, when thou prayest, enter into thine inner chamber, and having shut thy door, pray to thy Father which is in secret, and thy Father which seeth in secret shall recompense thee.

And in praying use not vain repetitions, as the Gentiles do; for they think they shall be heard for their much speaking. Be not therefore like unto them; for your Father knoweth what things ye have need of before ye ask him:

After this manner therefore pray ye:
Our father who art in heaven,
Hallowed be thy name.
Thy kingdom come,
Thy will be done, as in heaven, so on earth.
Give us this day our daily bread,
And forgive us our debts as we also have forgiven our debtors.
And bring us not into temptation, but deliver us from evil.

For if ye forgive men their trespasses, your heavenly Father will also forgive you. But if ye forgive not men their trespasses, neither will your Father forgive your trespasses.

3. Repent, Unto God.

Moreover, when ye fast be not, as the hypocrites, of a sad countenance; for they disfigure their faces that they may be seen of men to fast. Verily I say unto you, They have received their reward. But thou, when thou fastest, anoint thy head, and wash thy face, that thou be not seen of men to fast, but of thy Father which is in secret; and thy Father, which seeth in secret, shall recompense thee.

4. No Other Gods.

Lay not up for yourselves treasures upon the earth, where moth and rust doth consume, and where thieves break through and steal; but lay up for yourselves treasures in heaven, where neither moth nor rust doth consume, and where thieves do not break through and steal; for where thy treasure is, there will thy heart be also.

The lamp of the body is the eye; if therefore thine eye be single, thy whole body shall be full of light. But if thine eye be evil, thy whole body shall be full of darkness. If therefore the light that is in thee be darkness, how great is the darkness! No man can serve two masters; for either he will hate the one and love the other, or else he will hold to one and despise the other. Ye cannot serve God and mammon.

5. Have Faith in God.

Therefore I say unto you, Be not anxious for your life, what ye shall eat, or what ye shall drink, nor yet for your body, what ye shall put on. Is not the life more than the food and the body than the raiment?

Behold the birds of the heaven, that they sow not, neither do they reap, nor gather into barns; and your heavenly Father feedeth them. Are not ye of much more value than they? And which of you by being anxious can add one cubit unto his stature? And why are ye anxious concerning raiment?

Consider the lilies of the field, how they grow; they toil not, neither do they spin; yet I say unto you that even Solomon in all his glory was not arrayed like one of these.

But if God doth so clothe the grass of the field, which today is, and tomorrow is cast into the oven, shall he not much more clothe you, O, ye of little faith? Be not therefore anxious, saying, What shall we eat? or, What shall we drink? or, wherewithal shall we be clothed? For after all these things do the Gentiles seek; for your heavenly Father knoweth that ye have need of all these things.

But seek ye first his kingdom, and his righteousness; and all these things shall be added unto you.

Be not therefore anxious for the morrow, for the morrow will be anxious for itself. Sufficient unto the day is the evil thereof.

PICTURES OF THE LIFE.

1. Judge Not.

Judge not that ye be not judged. For with what judgment ye judge, ye shall be judged; and with what measure ye mete it shall be measured unto you.

And why beholdest thou the mote that is in thy brother's eye, but considerest not the beam that is in thine own eye? Or how wilt thou say to thy brother: Let me cast out the mote out of thine eye; and, lo, the beam is in thine own eye? Thou hypocrite, cast out first the beam out of thine own eye; and then thou shalt see clearly to cast out the mote out of thy brother's eye.

Give not that which is holy unto the dogs, neither cast your pearls before the swine, lest haply they trample them under their feet and turn and rend you.

3. For the Seeker.

Ask and it shall be given you; seek, and ye shall find; knock, and it shall be opened unto you: for every one that asketh receiveth; and he that seeketh findeth; and to him that knocketh it shall be opened.

Or what man is there of you, who, if his son shall ask him for a loaf, will give him a stone; or if he shall ask for a fish, will give him a serpent? If ye then, being evil, know how to give good gifts unto your children, how much more shall your Father which is in heaven give good things to them that ask him?

4. All in One Rule.

All things therefore whatsoever ye would that men should do unto you, even so do ye also unto them: for this is the law and the prophets.

5. Two Gates.

Enter ye in by the narrow gate: for wide is the gate, and broad is the way, that leadeth to destruction, and many be they that enter in thereby. For narrow the gate, and straitened the way, that leadeth unto life, and few be they that find it.

6. Two Trees.

Beware of false prophets, which come to you in sheep's clothing, but inwardly are ravening wolves. By their fruits ye shall know them. Do men gather grapes of thorns, or figs of thistles? Even so every good tree bringeth forth good fruit; but the corrupt tree bringeth forth evil fruit. A good tree cannot bring forth evil fruit, neither can a corrupt tree bring forth good fruit. Every tree that bringeth not forth good fruit is hewn down, and cast into the fire. Therefore by their fruits ye shall know them.

7. Two Classes.

Not every one that saith unto me, Lord, Lord, shall enter into the kingdom of heaven; but he that doeth the will of my Father which is in heaven. Many will say to me in that day, Lord, Lord, did we not prophecy by thy name, and by they name cast out devils, and by thy name do many mighty works? And then will I profess unto them, I never knew you: depart from me, ye that work iniquity.

8. Two Houses.

Every one therefore which heareth these words of mine, and doeth them, shall be likened unto a wise man, which built his house upon the rock: and the rain descended, and the floods came, and the winds blew, and beat upon that house: and it fell not: for it was founded upon the rock.

And every one that heareth these words of mine, and doeth them not, shall be likened unto a foolish man, which built his house upon the sand; and the rain descended, and the floods came, and the winds blew, and smote upon that house: and it fell: and great was the fall thereof.

And it came to pass, when Jesus ended these words, the multitudes were astonished at his teaching: for he taught them as one having authority, and not as their scribes.

Compilations of Vernalities.

New York Sun.

The tight shut window of the Winter ope,
The rubber plant breathes on the fire escape.
The early bird no more through gloom must grope.
The fur-lined coats no manly manly figures drape,
The subway air grows stuffy, as of yore,
The women wear new shoes of green or gray,
The poet sends these Spring things out once more,
The women lean from windows o'er the way.

The boys blockade the sidewalks spinning tops,
The crowds turn out on Sunday afternoon,
The banished iceman makes his daily stops,
The Brokebys say they'll go abroad in June,
The window washers oftener appear,
The green food stands move to the open air,
The tonics in the drug stores promise cheer,
The steam heat now is more than one can bear.

The Jonesby girls are talking naught but dress—
The topic sings in every woman's brain:
The Browns declare their gas is costing less,
The motor salesman works with might and main,
The Griggses say that they'll sublet their flat,
The yachtmen speak of overhauling boats,
The female population murmurs "hat,"
The movers view new houses, taking notes.