WILSON "SNOWFLAKE" BENTLEY: A LIFE STORY

From Primary and Secondary Documents

Objectives: Students will learn the difference between primary and secondary sources, and the values and challenges of working with both. They will learn about the life and work of pioneering snowflake photographer Wilson A. Bentley by analyzing, reading, and evaluating primary and secondary sources.

Time: 55 minutes *(Adjust Time As Needed)*

- introduction, *(suggested: 15 minutes)*
- small groups, *(suggested: 20 minutes)*
- large group discussion, *(suggested: 20 minutes)*

Skills: Reading, Critical Thinking, Document Based Questions and Answers

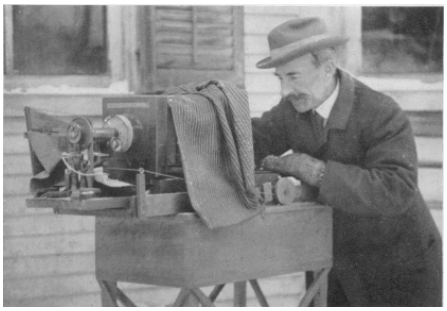
Content Area: Social Studies, Science

Materials: (contained below)

- Wilson A. Bentley letter and transcript
- Wilson A. Bentley article
- Obituary of Wilson A. Bentley
- Group worksheets

Grade Level: Grades 4 – 6

Historical Overview:

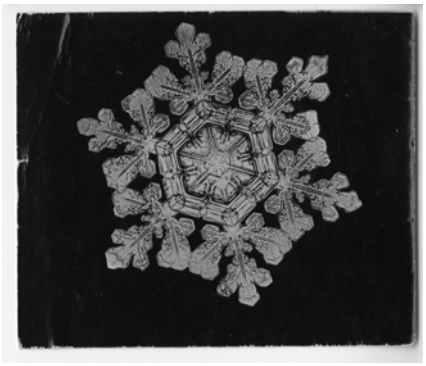


For over forty years, Wilson "Snowflake" Bentley (1865-1931) photographed thousands of individual snowflakes and perfected the innovative photomicrographic technique. His photographs and publications provide valuable scientific records of snow crystals and their many types. Five hundred of his snowflake photos now reside in the Smithsonian Institution Archives, donated by Bentley in 1903 to protect against "all possibility of loss and destruction, through fire or accident."

Wilson A. Bentley was born in 1865 in Jericho, Vermont. Taught by his mother, he lived and worked on the family farm. Growing up in the "snowbelt," where the annual snow fall is about 120 inches, Bentley developed an interest in snow crystals after he received a microscope for his fifteenth birthday. Four years

later, in 1885, then equipped with both his microscope and a camera, Bentley made the first successful photograph of a snowflake.

Bentley pioneered "photomicrography," the photographing of very small objects, especially of snowflakes. Snowflakes or snow crystals are difficult to photograph because they melt so quickly, but Bentley developed the equipment and technique that allowed him to take thousands of photographs of individual snowflakes. He connected his camera to a microscope in order to create photos that showed intricate details of each snow crystal and stood in the winter cold for hours at a time. Patiently, he caught falling flakes and carefully handled them with a feather to place them under the lens. The apparatus was set up outside so that the delicate specimens would not melt, and a minute and a half exposure captured the snowflakes.



From that first photograph in 1885, Bentley photographed more than 5000 snow crystals until his death in 1931. Within his massive collection, he noticed every single snowflake was unique, and in the year of his death he, along with William J. Humphreys, a physicist with the U.S. Weather Bureau, published *Snow Crystals*, a volume containing 2,300 of his photographs for all to study and enjoy. Throughout his life he also published sixty articles in various scientific and popular journals. While most of his articles discussed snow crystals, he also photographed and wrote about frost, dew, and other atmospheric phenomena.

In 1903, he donated a collection of 500 of his snowflake photographs to the Smithsonian Institution to ensure their safety. In his correspondence with third Smithsonian Institution Secretary Samuel Pierpont Langley, Bentley offered positives and slides of his photos, writing that he was "deeply grateful for your [the Smithsonian's] kindly help in thus placing my collection of snow photographs beyond all possibility of loss and destruction, through fire or accident." At that time he also sent a copy of a previous publication on the snow crystal photographs. Later, he sent a lecture he had given at the Brooklyn Institute of Arts and Sciences in 1905, intending that it would be edited and published by the Smithsonian, though it never was. Each item sent to the Smithsonian was stamped and numbered to help

keep track of the images. His photographs remain in the Smithsonian Institution Archives to this day, safeguarded from any misfortune.

Bentley remained in Jericho, Vermont throughout his life. Ever dedicated to his work, he died there in 1931 after having caught pneumonia walking through a blizzard.

Primary and Secondary Sources:

A **primary source** is any original source of information that provides a direct or first-person connection to a historical event. Examples may include: documents such as letters, diaries, birth certificates, receipts, and notebooks; photographs and drawings; objects, such as clothing or furnishings; oral history interviews, and home movies. Primary sources were created by a person who witnessed an event first-hand.

Secondary sources are summaries, second-hand accounts, and analyses of events. They were created by someone who did not witness the event, but may have read or heard about it. Examples may include: books or articles written on a topic, artworks depicting an event, letters or diaries recounting a version of events told to the author by another source.

One source can contain both primary and secondary information. For example, a diary entry that contains a version of events the author read in the newspaper (**secondary**) and the author's feelings about the event (**primary**). Whether a source is primary or secondary can depend on the question you ask. If you are looking for information on how an event occurred, the diary entry written from a newspaper article would be a secondary source (the newspaper article may be a primary source). But if you are asking how the author learned about an event, the diary entry written from a newspaper article would be a primary source.

Primary sources provide valuable information that we cannot find elsewhere. They speak to us in a first-person voice and bring history alive. They provide an individual's view of historic events and times, and they tell stories about how people lived and coped in the past. These letters, diaries, and photographs create engaging stories for students to learn about and relate to. By comparing conflicting primary sources, students learn to carefully examine actual documents,

as well as the words they contain, evaluate evidence and point of view, and develop critical thinking skills about the past and also about their world today.

Instructions for Teachers:

Explain the differences between a primary and secondary source to your students. Ask them to think of examples of both primary and secondary sources. Ask why they think primary sources are a valuable way to study history.

Read the historical context section to your students to introduce them to Wilson A. Bentley and his work.

Divide students into small groups. Print copies of the original documents and worksheets for each student in each group. Give each group one of the sources: the Wilson A. Bentley letter, the Wilson A. Bentley article, or the obituary of Wilson A. Bentley, alternating from group to group.

Before sending the groups to look at and read their respective original documents, describe the historical context of Solomon Brown's letters and life in Civil War Washington.

First have students examine the original documents carefully in their individual groups. Students should use the original documents and complete an analysis of the documents before they turn to the transcripts, which can be used for reading.

After students have looked at, read, and analyzed their sources and answered their questions in the small groups, bring the class back together for a large discussion. Have each group share a summary of their sources and the answers they found. Ask these questions to begin a discussion:

- What do these documents tell you about Wilson A. Bentley's life?
- Does one source help you to evaluate or better understand the information in other sources?
- When you combine these sources, is the whole greater than the sum of its parts?

Instructions for Students:

In your assigned groups, carefully examine, read, and analyze your source documents or images carefully. Answer the questions listed on your worksheet, using evidence from the documents or images to support your answers.

Wilson A. Bentley Letter

Names: _____

Questions:

1. Who wrote this letter?
2. When and where was this letter written?
3. What is this letter about?
4. Why was this letter written?
5. Who was the intended audience?
6. What was the point of view of the letter writer?
7. What does this letter tell you about Wilson Bentley's work?
8. What does this letter tell you about Wilson Bentley's personality?
9. How does the grammar/spelling and word use differ from today's writing style?
10. Is this letter a primary or secondary source, or both?
11. Are any/all parts of it a primary source, explain why or why not?
12. How could you check the accuracy of the information in the letter?

Wilson A. Bentley Article

Names: _____

Questions:

1. Who wrote this article?

2. When and where was this article written/published?

3. What is this article about?

4. Why was this article written?

5. Who was the intended audience?

6. What was the point of view of the article writer?

7. What does this article tell you about Wilson Bentley's work?

8. What does this article tell you about Wilson Bentley's personality?

9. What does the article tell you about the public's view of Wilson Bentley?

10. Is this article a primary or secondary source, or both?

11. Are any/all parts of the article a primary source, explain why or why not?

12. How could you check the accuracy of the information in the article?

Obituary of Wilson A. Bentley

Names: _____

Questions:

1. Who wrote this obituary?

2. When and where was this obituary written/published?

3. What is this obituary about?

4. Why was this obituary written?

5. Who was the intended audience?

6. What was the point of view of the obituary writer?

7. What does this letter tell you about Wilson Bentley's work?

8. What does this letter tell you about Wilson Bentley's personality?

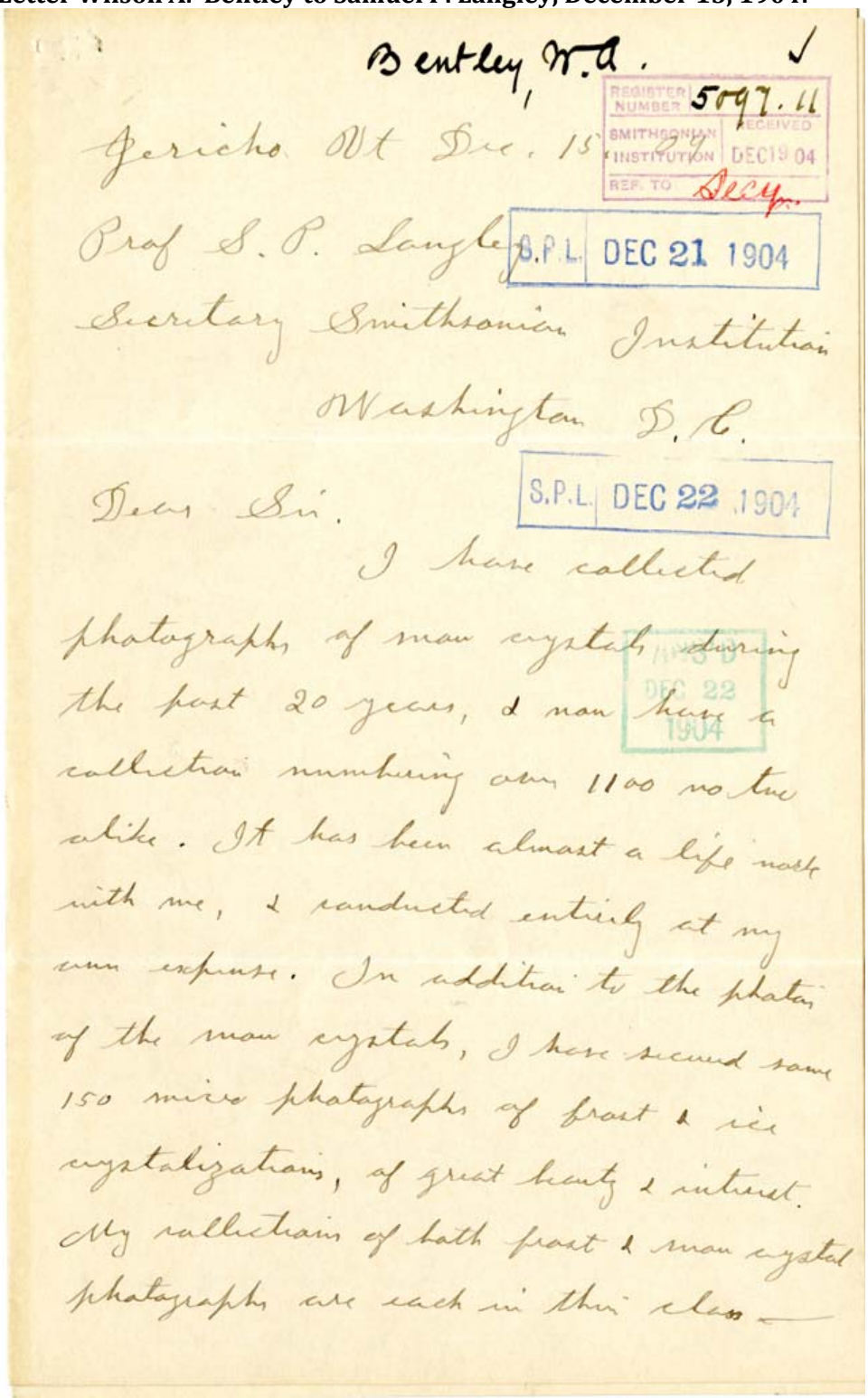
9. What does this obituary tell you about the public's view of Wilson A. Bentley?

10. Is this obituary a primary or secondary source, or both?

11. Are any/all parts of the article a primary source, explain why or why not?

12. How could you check the accuracy of the information in the article?

Letter Wilson A. Bentley to Samuel P. Langley, December 15, 1904:



Bentley W.A. ✓

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Jericho Vt Dec. 15 '04

Prof S. P. Langley
S.P.L. DEC 21 1904
Secretary Smithsonian Institution
Washington D. C.

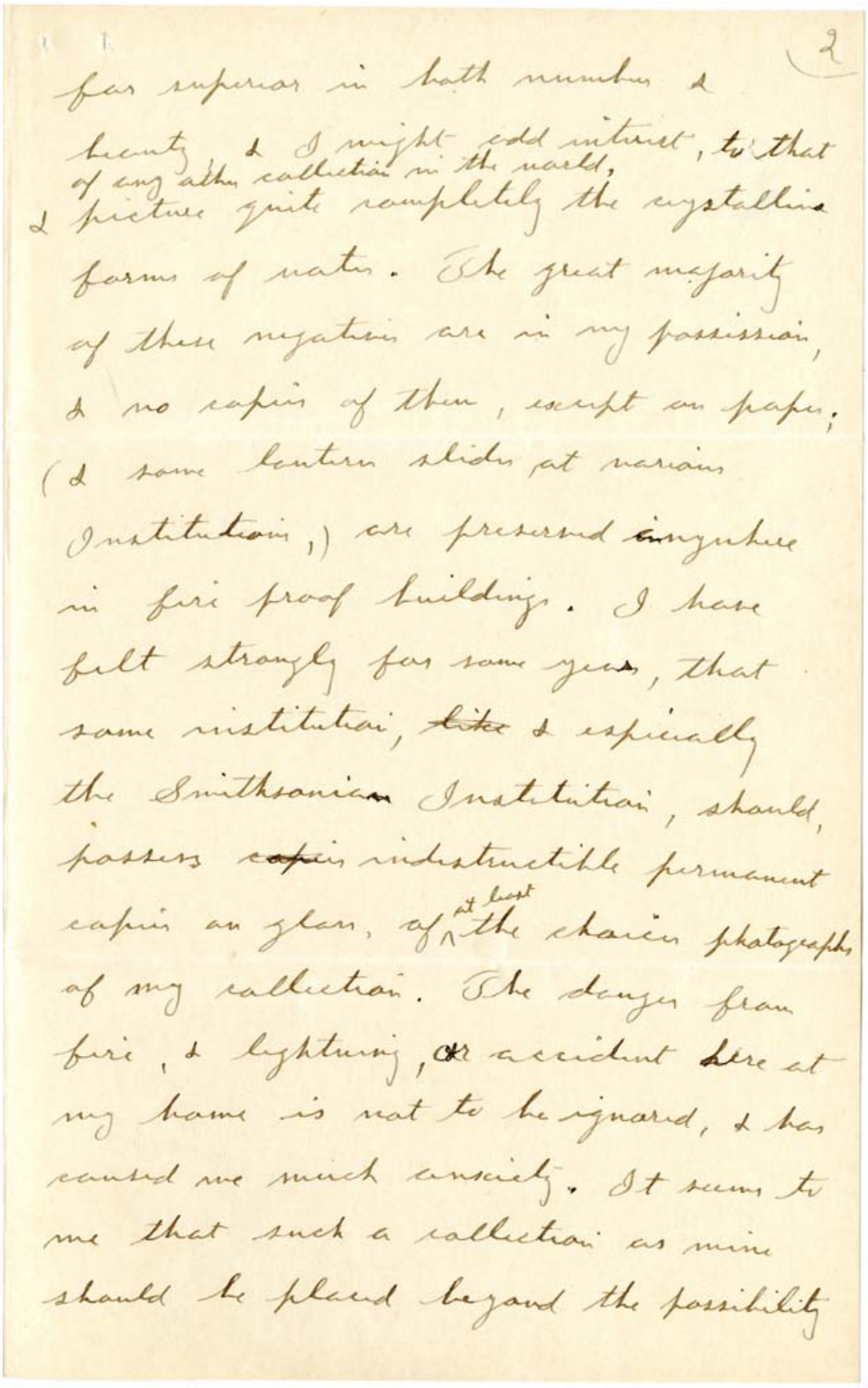
S.P.L. DEC 22 1904

Dear Sir.

I have collected photographs of snow crystals during the past 20 years, & now have a collection numbering over 1100 no two alike. It has been almost a life work with me, & conducted entirely at my own expense. In addition to the photos of the snow crystals, I have secured some 150 micro photographs of frost & ice crystalizations, of great beauty & interest. My collections of both frost & snow crystal photographs are each in their class —

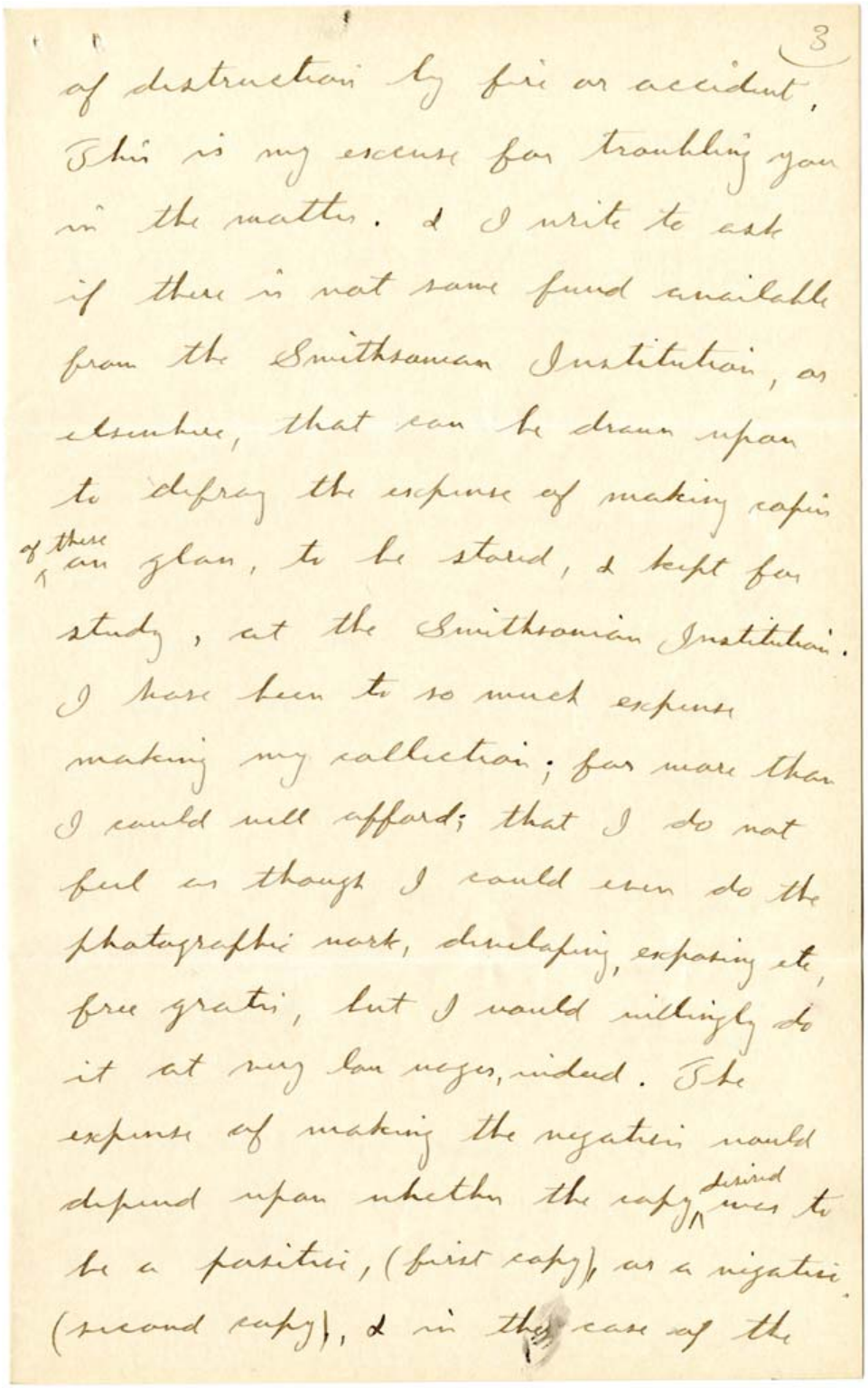
DEC 22 1904

Wilson A. Bentley to Samuel P. Langley, December 15, 1904, page 1, Smithsonian Institution Archives.
http://siarchives.si.edu/history/exhibits/documents/bentley.htm



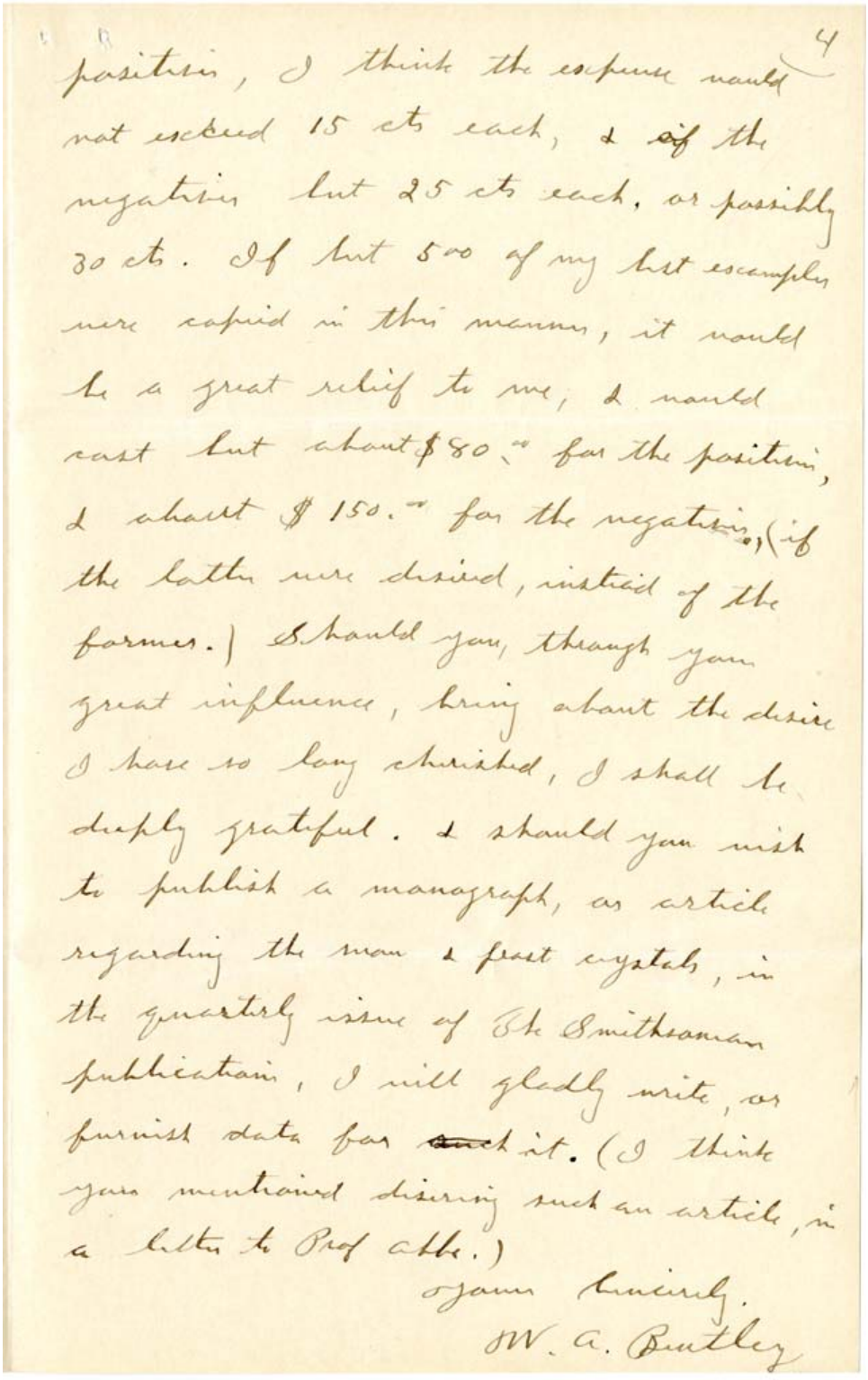
far superior in both number & beauty & I might add interest, to that of any other collection in the world, & picture quite completely the crystalline forms of water. The great majority of these negatives are in my possession, & no copies of them, except on paper; (& some lantern slides at various Institutions,) are preserved ~~in~~ anywhere in fire proof buildings. I have felt strongly for some years, that some institution, ~~like~~ & especially the Smithsonian Institution, should, possess ~~copies~~ indestructible permanent copies on glass, of at least the choicer photographs of my collection. The danger from fire, & lightning, ~~or~~ accident here at my home is not to be ignored, & has caused me much anxiety. It seems to me that such a collection as mine should be placed beyond the possibility

Wilson A. Bentley to Samuel P. Langley, December 15, 1904, page 2, Smithsonian Institution Archives.
http://siarchives.si.edu/history/exhibits/documents/bentley.htm



of destruction by fire or accident. 3
This is my excuse for troubling you
in the matter. & I write to ask
if there is not some fund available
from the Smithsonian Institution, or
elsewhere, that can be drawn upon
to defray the expense of making copies
of these ~~an~~ glass, to be stored, & kept for
study, at the Smithsonian Institution.
I have been to so much expense
making my collection; far more than
I could well afford; that I do not
feel as though I could even do the
photographic work, developing, copying etc,
free gratis, but I would willingly do
it at my low wages, indeed. The
expense of making the negatives would
depend upon whether the copy desired were to
be a positive, (first copy) or a negative
(second copy), & in the case of the

Wilson A. Bentley to Samuel P. Langley, December 15, 1904, page 3, Smithsonian Institution Archives.
http://siarchives.si.edu/history/exhibits/documents/bentley.htm



positives, I think the expense would
not exceed 15 cts each, & of the
negatives but 25 cts each, or possibly
30 cts. If but 500 of my best examples
were copied in this manner, it would
be a great relief to me, & would
cost but about $80.00 for the positives,
& about $150.00 for the negatives, (if
the latter were desired, instead of the
former.) Should you, through your
great influence, bring about the desire
I have so long cherished, I shall be
deeply grateful. & should you wish
to publish a monograph, or article
regarding the snow & frost crystals, in
the quarterly issue of the Smithsonian
publications, I will gladly write, or
furnish data for ~~such~~ it. (I think
you mentioned desiring such an article, in
a letter to Prof Abbe.)

Yours sincerely,
W. A. Bentley

Wilson A. Bentley to Samuel P. Langley, December 15, 1904, page 4, Smithsonian Institution Archives.
http://siarchives.si.edu/history/exhibits/documents/bentley.htm

Jericho VT Dec. 15, 04

Prof S. P. Langley

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Dear Sir,

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or frost crystals, in the quarterly issue of the Smithsonian publications, I will gladly write, or furnish data for it. (I think you mentioned desiring such an article, in a letter to Prof. [Cleveland] Abbe.)

Yours sincerely,

W. A. Bentley

"Photographing Snowflakes" article by Wilson A. Bentley:

PHOTOGRAPHING SNOWFLAKES

By W.A.Bentley

EVERY snowflake has an infinity of beauty which is enhanced by the knowledge that the investigator will, in all probability, never find another exactly like it. Consequently, photographing these transient forms of Nature gives to the worker something of the spirit of a discoverer. Besides combining her greatest skill and artistry in the production of snowflakes, Nature generously fashions the most beautiful specimens on a very thin plane so that they are specially adapted for photomicrographical study.

The photographing of snowflakes, although quite delicate work, can hardly be called difficult, although some hardships attend it, because the work must all be done in a temperature below freezing, and under conditions of much physical exposure. The temperature at which photography is possible depends somewhat upon the thickness of the crystals; this varies greatly from time to time, and depends upon whether the temperature is rising from an intense degree of cold or falling from a point above freezing. If rising after a cold snap, photographing can often be continued until actual thawing commences.

A Variety of Strange Forms of Snow Crystals: The Specimens near the Center Are of the Most Interest on Account of Their Rarity

Of course, location is everything in this work, and no one except those living in arctic climates or in regions having long and severe winters, can accomplish very much. Generally speaking, the western quadrants of widespread storms or blizzards furnish the most beautiful and perfect forms. At such times the wind is usually westerly or northerly, with the barometer standing at 29.6 to 29.9 in. and slowing rising. The percentage of perfect crystals is likely to be larger when the snowfall is not too thick and heavy, with the crystals medium to small in size rather than large. The character of the snowfall often undergoes quite abrupt changes as a storm progresses.

The apparatus required for snowflake photography consists of a compound microscope, fitted with a joint that permits the instrument to be turned down horizontally, at right angles to its base, so that it can be coupled to a camera bellows by means of a light-tight connection. The microscope objectives are used alone, without the eyepiece. It is best to have several different objectives; ½, ¾, and 3-in. combinations, which give magnifications of from 8 to 60 diameters (64 to 3,600 times), will serve well.

Ordinary daylight, coming through a window, is used for illuminating the crystal after it has been placed on a microscope slide, a tiny beam of light entering through the small aperture in the substage of the instrument. The apparatus is placed indoors, near by and facing a window. The room, the apparatus, and its accessories should always be away from any source of artificial heat, and at a temperature approximately that of the outside air. The necessary accessories are an observation microscope, a pair of thick mittens, microscope slides, a sharp-pointed wooden splint, a feather, and a turkey wing or similar duster; also, an extra focusing back for the camera, con-

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Bentley, Wilson A. "Photographing Snowflakes." *Popular Mechanics*, Volume 37, Number 2, February 1922, page 309.

taining clear glass instead of the usual ground glass, with a magnifying lens attached; this is used for final focusing. A blackboard, about 1 ft. square, with stiff wire or metal handles at the ends, so that the hands will not touch and warm it, is used to collect the specimens. As it is necessary to cover the end of the microscope objective with a strip of black card, that takes the place of the usual

Blocking Out the Snow-Crystal Images on the Photographic Negative: Right, Original Negative; Center, Negative Partly Blocked Out; Left, Completely Blocked-Out Negative

camera shutter which controls the duration of exposure, it is necessary to fit two vertical rods at each side of the microscope tube to hold the card.

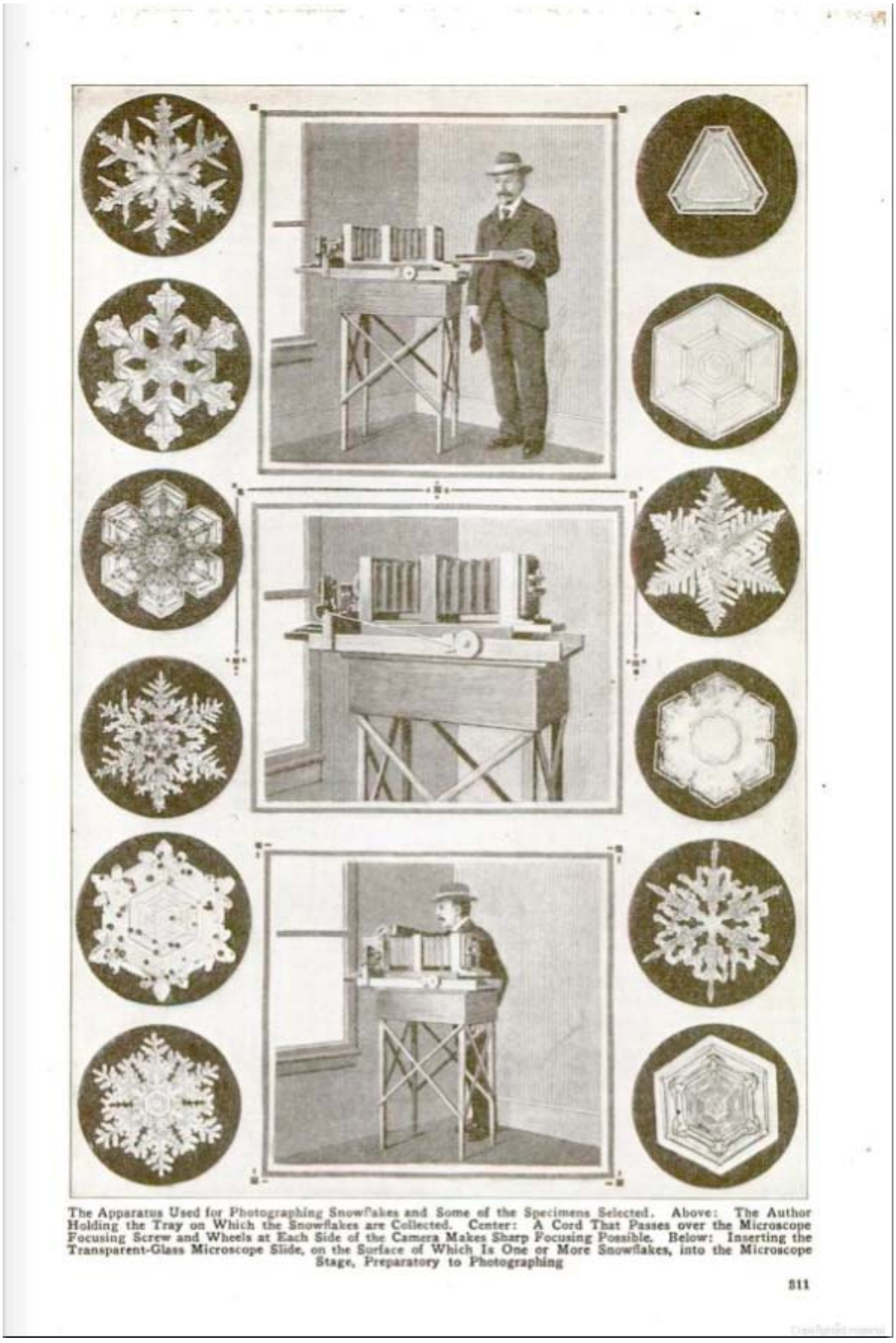
The snowflakes are caught on the blackboard as they fall, and examined by the naked eye or with the assistance of a hand magnifying glass. The feather duster is used to brush the board clean every few seconds, until two or more promising specimens alight upon it, when it is immediately removed indoors. From this point onward the photographer must work fast. The promising specimens are placed for a moment's observation under the observation microscope. The removal of the snowflake from the board to the microscope slide is accomplished with the sharp-pointed splint, which is pressed gently against the face of the crystal until the latter adheres to it, so that it can be picked up and placed on the glass slide. Usually several crystals are placed together on a single slide, a momentary glance being given to each, and care taken while doing this not to breathe on the crystals. The utmost haste must be used, for a snow crystal is often exceedingly tiny, and frequently not thicker than heavy paper. Furthermore, once these bits of pure beauty are isolated, evaporation (not melting) soon wears them away, so that, even in zero weather, they last but a very few minutes. When a desirable specimen is obtained, it is pressed flat against the glass with the edge of the feather and the slide inserted in the stage of the microscope on the camera stand, centered, roughly focused with the camera ground glass, then sharply focused with the clear-glass screen and magnifier, focusing on some tiny air tube near the center of the crystal. The plate holder is then inserted into the camera, the objective covered with the black card and the slide removed from the plate holder. The objective is then uncovered, and when the exposure, which may vary from 8 seconds to 100 or more, is deemed sufficient, the operation is reversed. Naturally enough, no rule for the length of exposure can be given, except that the greater the magnification, the longer the exposure should be.

The frail, feathery flakes are the most difficult to photograph, and it is always best to place five or six other crystals around the specimen, as this greatly retards the evaporation of the central one.

When working from the rear of the camera, and the bellows extension is such as to make it impossible to reach the focusing screw on the microscope, an arrangement similar to that shown in the page illustration can be used. This consists of a cord that runs over a wheel on each side of the camera and around the focusing screw. No lens is required in the camera, the microscope furnishing the optical equipment for projecting the images onto the sensitized plates.

Having recorded the fleeting substance of the snowflakes on the photographic negative and brought out the image by development, the photographer discovers that the body of the snow crystal is so transparent, that it does not contrast enough with its background to make a print in which the form will stand out in relief. There is no purely photographic method for producing the white images against a dark background, and yet it is necessary to do so if the images are to be

Bentley, Wilson A. "Photographing Snowflakes." *Popular Mechanics,* Volume 37, Number 2, February 1922, page 310.



The Apparatus Used for Photographing Snowflakes and Some of the Specimens Selected. Above: The Author Holding the Tray on Which the Snowflakes are Collected. Center: A Cord That Passes over the Microscope Focusing Screw and Wheels at Each Side of the Camera Makes Sharp Focusing Possible. Below: Inserting the Transparent-Glass Microscope Slide, on the Surface of Which Is One or More Snowflakes, into the Microscope Stage, Preparatory to Photographing

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Bentley, Wilson A. "Photographing Snowflakes." *Popular Mechanics,* Volume 37, Number 2, February 1922, page 311.

appreciated by most people, whose ideal of snow is that of immaculate whiteness. The only effective method of accomplishing this result is what is known among photographers as "blocking out."

The negative is supported on an ordinary retoucher's desk, which may be merely a piece of glass, arranged to hold the negative so that the image is illuminated by transmitted light. Then, with an etching knife or other fine, sharp-pointed tool, the operator proceeds to scrape away the emulsion around the outline of the crystal to leave it standing alone against a background of clear glass. This requires considerable patience, and often considerable time as well. In order to avoid irreparably spoiling the original negative, it is best not to alter it in any way, but to make a copy negative on which the actual blocking out is done. After the negative has been thus prepared, prints or lantern slides are made in the usual manner. Blocking out the negatives is done indoors, instead of outdoors as shown by the photograph, which was thus taken to get sufficient light to allow the exposure to be made.

Alarm Clock Turns on Electric Lights

The use of artificial light in poultry houses has become quite popular, as, by increasing the number of hours of light, the hens have more time for feeding, and lay more eggs. Where electric lights are used in the morning, say from 4:00 a. m. until daylight, the alarm-clock time switch illustrated will be found very useful.

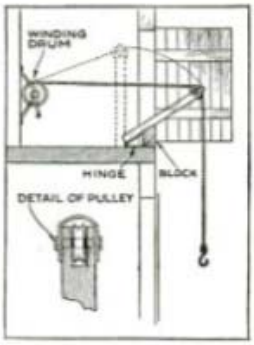
A piece of light, flexible chain, passing over a small pulley, has one end fastened to the handle of the light-controlling knife switch, while a weight is attached to the opposite end. A nail is run through a link of the chain, about level with the alarm-wind key of the clock. One end of this nail is supported on a small block immediately behind the clock and the other rests on the alarm key of the clock, after it has been wound. This arrangement holds the chain and weight, and provides for enough slack chain to leave the switch open. When the alarm goes off at the time set, the alarm key turns and allows the nail to slide off; the weight drops down and closes the switch.

Cleaning Plowshares

To keep plowshares and moldboards, as well as cultivator shovels, from rusting during the time they are laid up, it is best to give them a liberal coating of some thick grease. If the grease hardens on the surface so that its removal is difficult when the implement is to be used, a small amount of gasoline or kerosene may be poured over the share, and ignited just before the plow is to be used. The heat, together with the solvent action of the gasoline, will soften the grease, and if the plow is started in the ground while the grease is still warm, the coating will peel off easily and completely. A handful of dry hay or grass ignited under the plowshare will answer in the absence of gasoline. Either of these methods is better than scraping the grease off.

A Simple Farm Hoist

A simple hoist that will find many uses about the farm, for raising bags of grain and other bulky weights to the upper floor of a barn or other building, is shown in the drawing.



A wooden beam, of suitable thickness and length, is hinged to the floor at a convenient point inside the door or other opening. The upper end of the beam is provided with a single-sheave pulley, over which the rope passes to the winding drum; this can be easily improvised. A wooden block can be made and inserted underneath the projecting beam so that the arm is held in an inclined position, as shown. The packages are raised clear of the building and, when they reach the pulley, swing inward as the arm rises to a vertical position.

Bentley, Wilson A. "Photographing Snowflakes." *Popular Mechanics*, Volume 37, Number 2, February 1922, page 312.

Frank Thone Obituary of Wilson A. Bentley:

METEOROLOGY

Every Snowflake a Unique Jewel

In Over Forty Years of Photographing "the Faery Daughters Of King Boreas", Wilson Bentley Never Found Two Alike

By FRANK THONE

UP IN THE mountains of Vermont, where the winters are long and the snow falls frequently, there died a few weeks ago, a quiet, retiring man who was the world's foremost snow artist. His name was Wilson Bentley. He was not one of the numerous tribe of Michelangelos of melting marble, whose snow sculptures get into the newsreels and rotogravure sections. His was a far more difficult art, for it dealt with single flakes rather than great lumps of matted snow; yet though it dealt with single flakes it was a more permanent art than the efforts of these gravers of the earth's most impermanent plastic.

For Wilson Bentley made photographs of snowflakes: he was Portraiteur to Their Highnesses, the faery daughters of Old King Boreas. For more than forty years, he let the winds of the world bring beauty to his humble doorstep on a small farm near the village called Jericho; he captured it in its most fragile form and held it for a moment while the chilled kiss of the cloud-hidden sun has graven its lineaments in the invisible silver grains of photographic plates. For forty years he accumulated his portraits of princesses in frosty filigree, treasuring them as a less wise man might treasure the jewels they resemble or fine silver pieces whose smiths might learn lessons from their incredibly exquisite patterns. For at least a part of the forty years he had recognition from a few scientists who would read the riddles of the weather, artists who love beauty and will follow her even to Jericho. But the world heeded him not, nor knew his work.

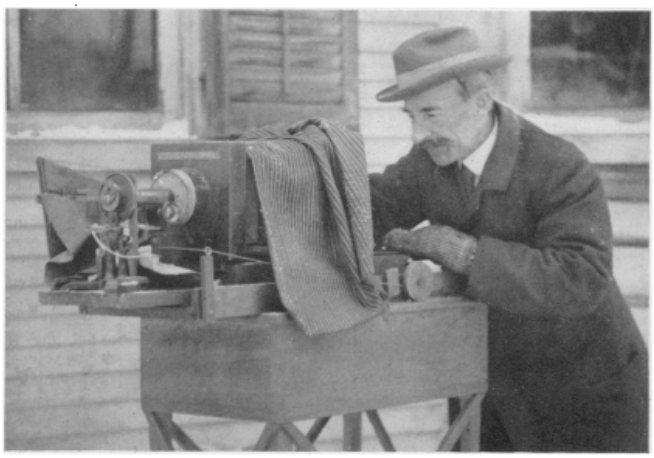
So far as that goes, even his friends of the outside world who sought him in his home in the hills, and once or twice coaxed him out for a few days of discomfort in the big cities—even his friends "from outside" knew very little about him. He was not a scientist in a great laboratory, for all his magic with the microscope and his cunning with the camera. Nobody knew what he did for a living. He said he was a poor man, and it is true he lived most unobtrusively and plainly, as it is still possible to do in a New England village community without losing caste. But so also have some of the world's richest lived: men like John Borroughs, and his own fellow New Englander, Thoreau, and the barefooted little man, centuries ago, whom his neighbors called "Il Poverello" when they came in admiring crowds to hear him talk.

A Hoard of Beauty

His friends of the outside world for years felt considerable concern over the fate of his great collection of plates and photographs. Hundreds upon hundreds they piled up in his little house, a hoard of beauty almost lost to the world. They felt like overprivileged guests, when they were allowed to see with only a few pairs of appreciative eyes what they knew thousands would be glad to behold. Some of them cast about in their minds for ways and means.

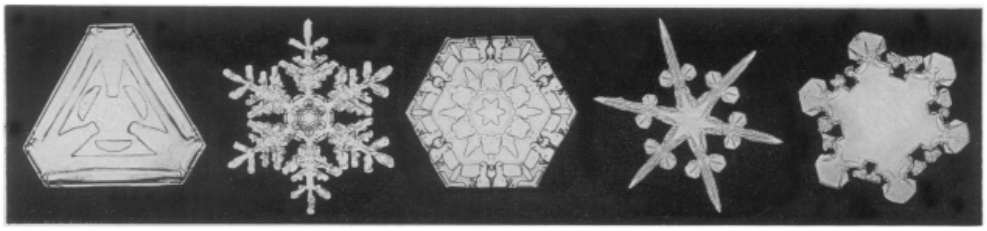
To Prof. W. J. Humphreys, physicist of the U. S. Weather Bureau, it seemed that the medium at once the happiest and most practicable would be a book, collecting all of these pictures into a series of fine photographic plates. This would permit the world at large to see in its own houses the treasures that had hitherto been visible only at the cost of a pilgrimage to Jericho, and it would at the same time place this treasury of loveliness safely beyond the irreparable loss that a single fire or other disaster might have caused had it visited Mr. Bentley's home and destroyed his collection of plates and prints.

But such an undertaking would be expensive. There would be no profit in such a book, for it would have to sell at a rather high price to a comparatively limited number of people. A fund would have to be provided to defray a lot of preliminary expenses. A generous donor came forward with the fund, and the American Meteorological Society became its trustees, sponsoring the book. Hours and days of tedious labor would be required, to arrange the two-thousand-odd photographs in their most effective order and to write a few pages of carefully built explanatory text. Prof. Humphreys undertook this labor himself. A publisher would have to be found. The McGraw-Hill firm accepted the book gladly, though they knew they would be doing well to break even on it financially. The whole way was not easy, but such was the charm of Wilson Bentley's pictures that everybody who had anything to do with the task shoul-



". . . CAPTURING IMMORTAL BEAUTY OUT OF GRAY SKIES . . ."
The late Wilson Bentley and his apparatus for photographing snowflakes.

Thone, Frank. "Every Snowflake a Unique Jewel." *The Science News-letter*, Volume 21, Number 565, 6 February 1932, page 90.



dered his share willingly for the sake of the end they all sought.

Only Wilson Bentley himself hesitated, with characteristic self-effacement and equally characteristic New England caution.

"Surely nobody's going to want a great big book like the one you are talking about," he said to Prof. Humphreys. "Hadn't we better get out a *little* one first, and see how it'll go?"

But Prof. Humphreys had his way, and the book came out, and Wilson Bentley had the great satisfaction, in his last days, of seeing his work in permanent form. In it the eminent scientist, who was proud to have his name set down as co-author with that of plain, untitled Wilson A. Bentley, tells something of the technique used in capturing the breath-taking beauty that flocks through the many pages of pictures.

Snow Surgeon

"Breath-taking" is the right phrase, too; for when you look at a snowflake through the microscope you must hold your breath. The warmth of the slightest puff from human lungs melts it at once; even the radiation from one's body will destroy it in a short time.

So the first requisite for a snowflake photographer must be a willingness and an ability to work in the cold. A picture of Wilson Bentley at his microscope-camera shows him in a thick overcoat and with his hands encased in substantial woollen mittens. How he was able, in this necessary armor against the cold, to perform swift and delicate manipulations that would put severely to task a neural or optical surgeon is one of the mysteries of his craft. Perhaps that is one of the things that come with practice—and Wilson Bentley had forty years and more of that.

The task of transferring the evanescent beauty of the snowflakes to the more permanent record of the photographic plate is well told by Prof. Humphreys himself:

"First you catch your snow crystal. This is conveniently done by holding a smooth black board, a foot or so square, a moment or two, or as long as necessary, in the falling snow. The catch is then taken under shelter, to keep it from being blown off the board or otherwise disturbed, where the light is good and the temperature that of outdoors. After a hasty inspection with a suitable magnifying glass a promising crystal, if one is found, is transferred carefully and with most delicate touch to a suitable glass plate—a microscope slide—with a small wooden splint, and there pressed down flat or brought into other proper position and made slightly to adhere to the glass by the gentle stroke of a small wing feather. After this it should be more minutely examined with a microscope to determine whether or not it is worthy of photographic preservation. If it seems to be worthless there is nothing to do, of course, but start all over again. When, however, a photograph of a crystal is to be obtained it obviously is necessary to take it with a photomicrograph camera, that is, a microscope fitted with a camera bellows and plate holder where the eyepiece normally is placed, or farther removed. The camera is turned toward the sky (clouds actually) either directly or through a window; then, or previously if more convenient, the crystal, adhering to the glass slide, is properly centered in front of a low-power, ½ to 3-inch microscope objective, and the focusing so adjusted as to give a picture of the desired size. The plate holder is then put in position, lens covered, slide of plate holder drawn, lens uncovered for time of exposure, lens covered again, and slide put back."

It all sounds very simple. But just try and do it!

But the handling of the snowflakes themselves is only a part, though perhaps the most difficult part, of the task of snowflake photography. There is yet another delicate operation that must be performed before the image can be transformed from the developed plate to photographic paper.

As the original plates come out of the dark-room, there is not much contrast between the picture of the flake and the background, for the exposure is necessarily made against a gray sky. To obtain this contrast, Mr. Bentley made a duplicate of each plate, and then carefully peeled all the background emulsion away with a very sharp knife, leaving only the clear glass around the image. Then when he made his print he got the image standing out in all its lacy delicacy against a dead-black background.

The hair-fine lines on a snowflake picture, that make it like a jewel, like a wrought silver brooch, like a pattern of lovely lace, are not really dark marks on its surface or in its substance. The whole of a snowflake is just a crystalline bit of ice, quite without color. But though a snowflake is one crystal, its unity is a manifold unity; it is a many-in-one. It is made up of united smaller crystals that have grown in harmony from a small original nucleus at the center. All of these smaller crystals let light straight through in certain directions, and turn it sharply aside in other directions. Where the light is turned away from our eyes it naturally seems to leave a dark line. Thus the markings on a snowflake.

Fascinating and Baffling

It is fascinating—and baffling—to go through the collection of snowflake pictures, seeking duplicates. There are none. In his forty winters of snow study and photography, Wilson Bentley never saw two snow crystals exactly alike. Instead, he found the most bewildering variety.

While he was arranging the pictures, Prof. Humphreys was not always the scientist. Often he was the imaginative small boy, seeing birds and butterflies and flowers, and even milk-bottles and the heads of hippopotami. He points out some of them in the book, but wisely leaves most of these fascinating little voyages of discovery for the beholder to make for himself.

But even as the serious scientist, Prof.

Thone, Frank. "Every Snowflake a Unique Jewel." *The Science News-letter*, Volume 21, Number 565, 6 February 1932, page 91.

Humphreys has things to point out that are of interest to everybody. For instance, that the shape and substance of a snowflake is determined largely by the height of the cloud from which it falls. The higher the cloud, the colder and drier the air, the more slowly the crystal forms and the "plainer" its outline. The small, even-sided, little-branched flakes are the children of the dizzy heights where haloes circle round the moon. The feathery, lacy, starry flakes, with endless intricate branches, are formed in damper air at lower temperatures, and at less lofty altitudes. The intermediate forms come from moderate heights, medium temperatures, middle-of-the-way conditions all round.

Older than Greeks

A perfect symmetry is rarely found in any snow crystal, even when its growth has not been violently disturbed. To the eye, most of Wilson Bentley's crystals appear flawlessly even in all proportions. But if one applies a rigorous measurement test one finds slight unevennesses. For instance, it is hard to find one pattern on which one can set down a pair of compasses and trace a circle that will just touch all six of its points, or on which one can lay down a ruler that will lie absolutely parallel with any of its sides.

For this hair's-breadth swerving from absolute mechanical accuracy, that satisfies the eye with symmetry and yet escapes a deadly sameness, the ancient Greek architects are much praised. But it appears that this idea in design is much older than the Greeks.

Science News Letter, February 6, 1932

ENGINEERING

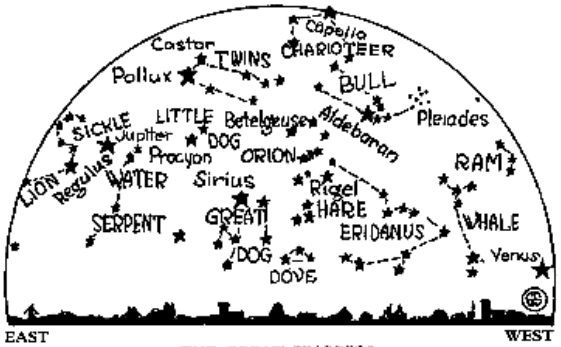
Streamline Type Challenge To Automobile Makers

BECAUSE it conforms to natural laws, not subject to the ingenuity of man, the streamlined automobile with its engine in the rear, is challenging manufacturers of the world's 28,000,000 motor vehicles to adopt it as the design of smart appearance which will give maximum riding comfort and greatest economy at high speed. This opinion is presented in a report to the Society of Automotive Engineers by Sir Dennistoun Burney, noted car designer.

Pointing out that the streamlined car would reduce air resistance by half, as compared with present-day designs, Sir Dennistoun explained how the distribution of weight in an automobile and the location of its center of gravity are of prime importance to safety and comfort. In order to give maximum adhesion to the road when brakes are applied equal strain must be placed upon each of the four wheels, and this may be achieved, he said, only when the engine is situated at a point one-third of the length of the wheelbase in front of the rear axle.

At ordinary driving speeds, Sir Dennistoun stated, the unpleasantness of an uneven road is most keenly felt. By arranging the weights along the length of the car according to a formula based on physical laws, he continued, it is possible greatly to reduce the magnitude of impacts and shocks which must be taken up by the springs of the modern car.

Science News Letter, February 6, 1932



THE GREAT WARRIOR

This map of the southern skies during February should replace the one published last week on page 71 with the article "Reforming the Stars." In that map there was a duplication of the planet Jupiter and an incorrect showing of the planet Mars, the result of an art department mistake. Familiar Orion, most magnificent of the constellations, occupies the center of the southern stage.

Thone, Frank. "Every Snowflake a Unique Jewel." *The Science News-letter*, Volume 21, Number 565, 6 February 1932, page 92.

Additional Resources:

Texts:

Bentley, Wilson A. *Snowflakes in Photographs*. Reprint. Dover Pubications, 2000.

Martin, Jacqueline Briggs, and Azarian, Mary, illustrator. *Snowflake Bentley*. Sandpiper, 2009.

Reliable websites with documents online:

SI Stories, Smithsonian Institution Archives,
http://siarchives.si.edu/history/exhibits/documents/index.htm

Smithsonian Institution Archives History Pages,
http://siarchives.si.edu/history

Smithsonian Institution Archives Home Page,
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Historic Pictures of the Smithsonian, Smithsonian Institution Archives,
http://siarchives.si.edu/history/exhibits/historic-pictures-smithsonian

Smithsonian Institution Education site,
http://www.smithsonianeducation.org/educators/

Jericho Historical Society Snowflake Bentley Site, http://snowflakebentley.com/

SBentley Snow Crystal Collection of the Buffalo Museum of Science,
http://bentley.sciencebuff.org/index.htm

Snow Crystals.com - An online guide to snowflakes, snow crystals, and other ice phenomenon, created by Kenneth Libbrecht, Professor of Physics at Caltech (California Institute of Technology)

Snow Crystals, Our Friends – an online guide by James Provencio, Katie Ohsann, Stephen Barta, and Dave Gosselin, from the University of Arizona