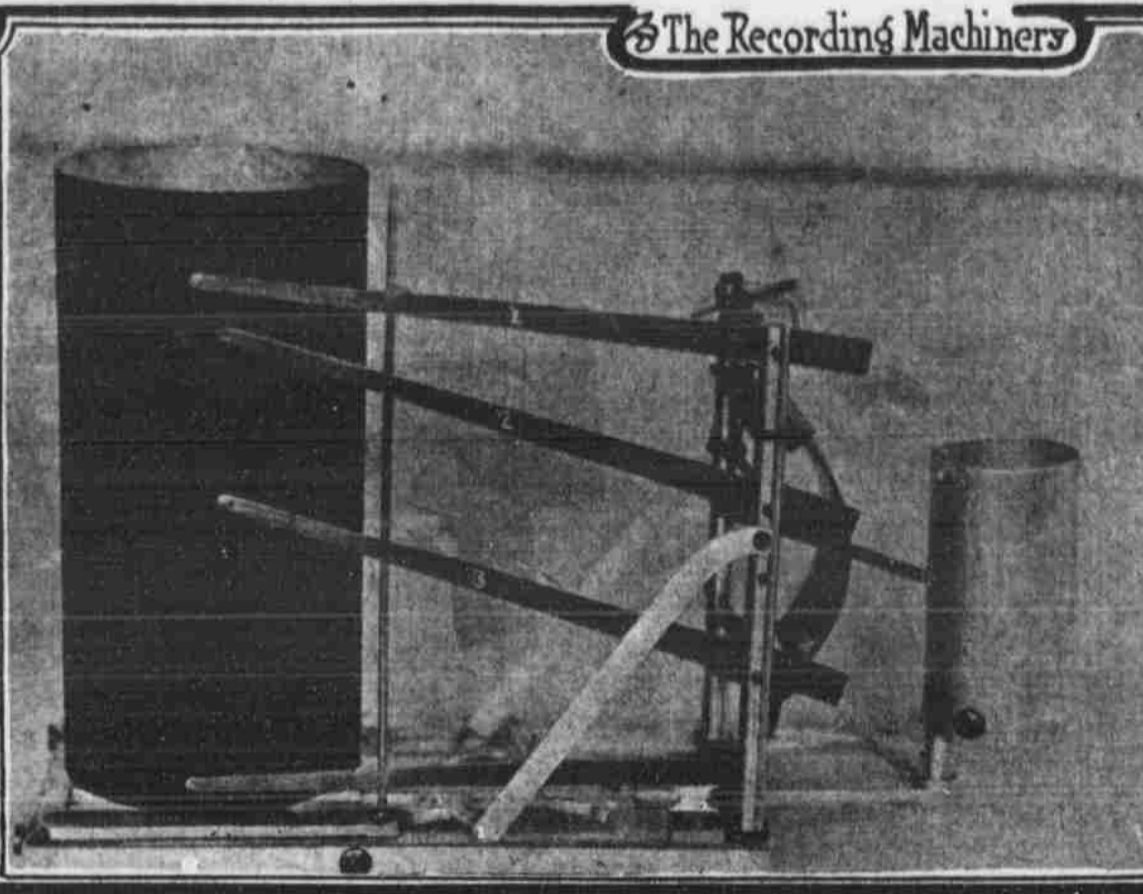


## BALLOONING FOR WEATHER AT FORT OMAHA

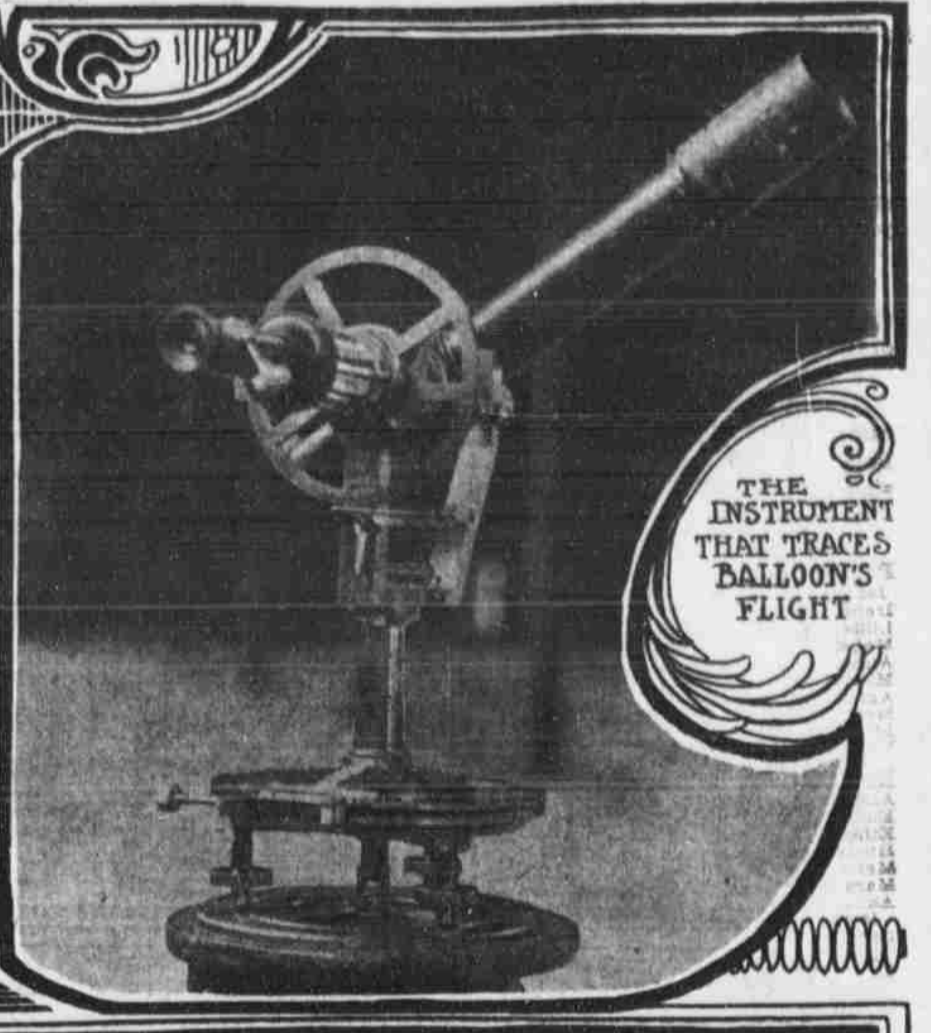
Interesting Experiments Intended to Afford Data for Determining Conditions That Prevail in the Upper Strata of the Atmosphere



FOLLOWING FLIGHT OF BALLOON WITH THEODOLITE C.S. WOODS AT INSTRUMENT — W.R. GREGG NOTING OBSERVATIONS.



The Recording Machinery



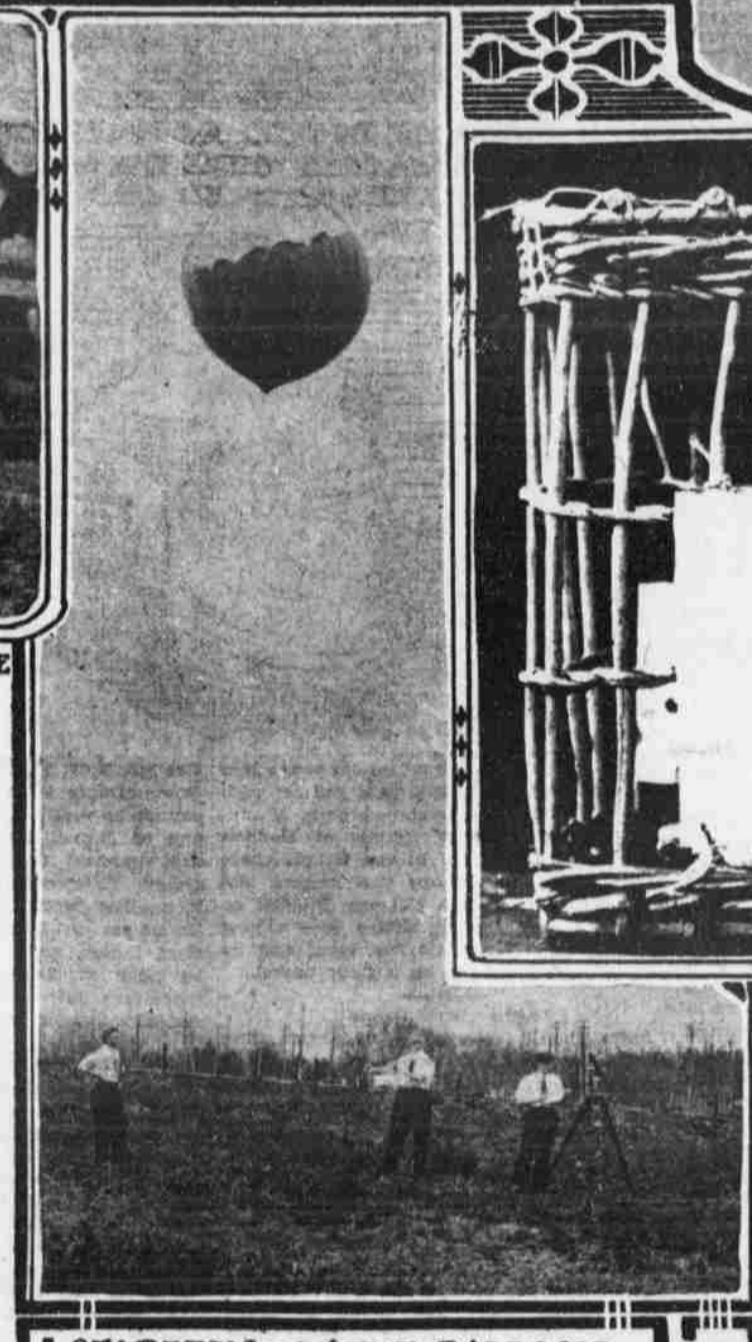
THE INSTRUMENT THAT TRACES BALLOON'S FLIGHT



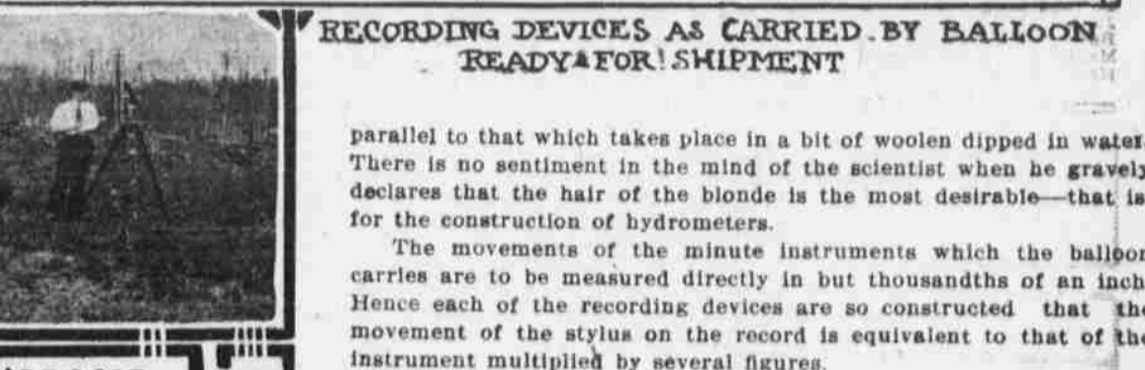
WATCHING OPERATIONS AT FORT OMAHA BALLOON HOUSE



**NOTICE**  
Hydrogen Gas Keep Away From Fire!  
If the filler will kindly pack in a box this Balloon, Cover, and Basket the Basket contains a meteorological instrument and record, WITHOUT OPENING OR DISTURBING CONTENTS in any manner, and return by Express Collect, to  
Mount Weather Observatory,  
Blumont, Va.  
TWO DOLLARS will be paid for the service. Please fill out and mail the card inside this envelope, also use the inclosed tag on the express package.



STARTING OFF THE BALLOON



RECORDING DEVICES AS CARRIED BY BALLOON READY FOR SHIPMENT

FOR CENTURIES men have been unraveling the mysteries of the heavens above and probing the secrets of earth beneath, but the air we breathe and winds that bring the changes that have come to be called weather are only now yielding to the efforts of the investigators. Earth is wrapped with a covering of atmosphere which can only be compared to an ocean. It has its currents, its tides and waves in fantastic variety. The craft by which man can sail this gaseous sea cannot navigate beyond a very few miles from port, so there has through all the centuries remained a great undiscovered realm of the upper air. Science has found a way to penetrate into this azure wilderness of space for a few miles more and now they are writing the stories of the skyland on the pages of the book of human knowledge.

The United States weather bureau has devised an apparatus to be carried far into the upper air to automatically record the conditions met there and return to earth again with the record of its travels. Small spherical balloons with a lifting power of scarce half a dozen pounds carry enough intricate instruments into the distances of the sky to ascertain the temperature, the height and the barometric pressure at every point in the journey as accurately as though the observations were being made on the laboratory work bench.

The extent of this ocean of air in which the earth is submerged is yet unknown. Estimates, largely conjectured, have placed the depth of the sea of air at perhaps 150 miles, and long this has been an accepted figure. The "sounding balloon," as the experts of the Mount Weather, Va., station, the headquarters of the explorers of the upper air, call their device, has shown that there is probably little atmosphere worthy of the name above fifty miles from the surface of the earth. The range of investigation is limited to the journeys of the sounding balloons, which have thus far not penetrated beyond eighteen miles. In that distance, however, a fair idea of the nature of the whole body of air has been gained. Investigations now lead the scientists to believe that the conditions that prevail in the upper air are but little changed in the space included in the distance beginning at six miles from the earth to the outmost limits of the gaseous envelope. Up there they say it is just a vast expanse of attenuated gas, thin almost to nothingness, cold as the space between the stars and dazzlingly bright with the uninterrupted rays of the sun. There can be no live thing there in that void of chill.

Into this forbidden bourne the weather balloon can penetrate for one glimpse around and then the long, swift plunge back to the warm living world below.

Fort Omaha, chosen because of its position in the "storm track," is the center of the series of experiments which the weather bureau is conducting in exploring the upper air. C. S. Woods and W. R. Gregg, research observers from the Mount Weather station, are here daily turning loose balloons to sound the depths of the sky. Similar investigations were conducted by them here last year.

These men have been detailed to make an effort to pry into the secrets of the comet, too. When Halley's comet came swinging by on May 18 balloons were liberated to make their way up into the region beyond the clouds. It may be that the recording instruments will have a tale to tell when they come back, but there is nothing certain about it. If the passage of the earth through the tail of the comet affects the temperature, the barometric pressure or the humidity of the upper air the instruments will tell. To other influences they are inoperative.

Omaha has proven, perhaps, the best location in the country for the investigation of the upper air. Out here in the broad basin of the Missouri river country the vast sea of air is little influenced by mountains and the great bodies of water. It is across this territory that the storm sweeps with the most frequency, and here the most often are the investigators able to send their inquiring apparatus up to the centers of the atmospheric disturbances which they are studying. The operation of the weather bureau's sounding balloons, too, requires a well populated country that the instruments may be recovered again when they come down from the skyward journey. The search for the little basket of instruments in a great wild stretch of country would be a hopeless task, while in the fields of Nebraska and Iowa they are certain to be found by someone in the course of a few weeks, or months at most, and then returned to Mount Weather.

The investigations made with the sounding balloons have given the weather observers an array of facts which, pieced together, have caused them to arrive at the conclusion that the air is divided into three layers. The first of these, that which lies next to the earth, known as the storm region, lies about two miles deep over the face of the world. The second layer, called the intermediate region, varies from two to six miles in thickness, while from above this on through space the third as far as the exploration has extended, and

probably as far beyond as the air extends. This third region is technically called the "permanent inversion," because so far investigations show that the temperature tends to increase with altitude, which is the reverse of conditions in the lower two strata of the atmosphere.

In the first strata the phenomena which constitutes the weather of the earth occur. However, the other strata are believed to have an influence, but one which is far from completely understood. In this layer, as every casual observer of the weather knows, changes in temperature are frequent and irregular, while the air is much disturbed by shifting currents. In the second layer of air, above two miles, the air is of a more uniform temperature, diminishing rather regularly with altitude. The "permanent inversion," or third layer, has sometimes been called the "isothermal layer," in that temperature changes are relatively small.

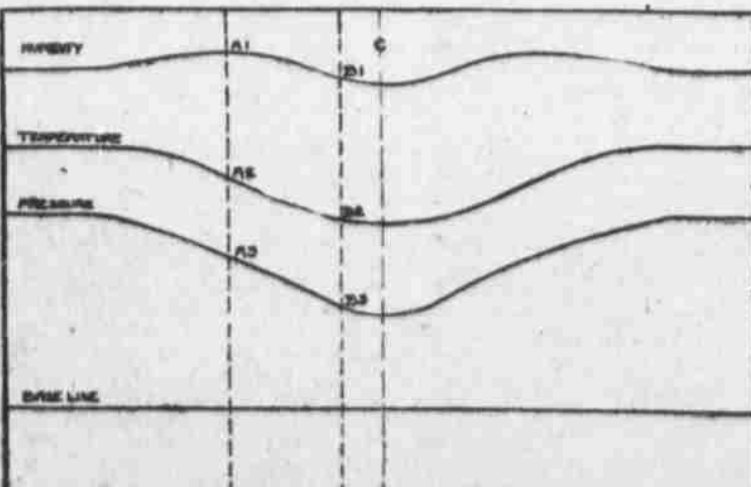
"In the investigations made at Omaha last year five of the sounding balloons reached the third layer," said Mr. Wood of the weather service. "The lowest altitude at which it was reached was five and a half miles and the highest nine and a half. This makes the average of the base of this region for the five days on which the soundings were made seven and a half miles. The average temperature at this point was 70 degrees, Fahrenheit, below zero. The increase of temperature with altitude is shown in the comparison of some of the records taken at that time. On October 12 of last year the temperature of 17 degrees below zero was registered at an altitude of fifteen miles, 61 degrees below at eleven miles on October 11 and 58 degrees below at ten and a half miles on September 28."

While ascensions were being made last year at Omaha other representatives of the Mount Weather observatory were engaged in similar operations at Indianapolis. While the maximum height reached there was twelve miles, the Omaha record was fifteen miles. One of the Omaha balloons traveled the unusual distance of 400 miles, landing with its records safely at last at Palmyra, Mo. The lowest temperature reached by the Omaha balloons was 92 degrees below zero at an altitude of ten miles on October 6. Those same experiments are being repeated this month on a large scale. With kites the Mount Weather station is constantly in touch with conditions in the air at distances up to two miles, and on rare occasions is able to put kites up to a distance of four miles. Kites have never reached the permanent inversion.

From the time that the sounding balloon is cast adrift in the sky until it is far out of sight of the unaided eye it is kept under observation by the investigators through the use of a theodolite. For seventy miles this little six-foot sphere can be followed on its travels in a clear sky. Readings from the theodolite showing the direction of the balloon with reference to both the horizontal and vertical planes of motion are taken at intervals of one minute so long as it remains visible. By the record of the theodolite and of the barometer on the balloon its travels can be traced accurately on the map. The problem becomes a comparatively simple process of triangulation.

Even before the balloon lands with its records calculations of its travels are possible through the knowledge of the angles which it has followed, and the average rate of rise which these instruments attain, an upward velocity of about eight feet a second.

The return of the balloons depends on the chance that they will be found, and that the intelligent finder will read a card which the basket of instruments carries, offering \$2 for its return by express to the Mount Weather observatory.



RECORD TAKEN BY AERIAL MACHINERY

parallel to that which takes place in a bit of woolen dipped in water. There is no sentiment in the mind of the scientist when he gravely declares that the hair of the blonde is the most desirable—that is, for the construction of hydrometers.

The movements of the minute instruments which the balloon carries are to be measured directly in but thousandths of an inch. Hence each of the recording devices are so constructed that the movement of the stylus on the record is equivalent to that of the instrument multiplied by several figures.

This is accomplished by a wonderfully simple arrangement. The ends of the thermometer strips and the hydrometer filament are attached to the short end of the lever which operates the stylus. The slight movement on the short end results in a very much longer movement on the end of the long arm which makes the wave line on the sooted surface. Not the slightest motion of the instruments escapes the record of the delicate tracery of the aluminum cylinder.

The record taken from the cylinder after the balloon has returned to earth is written in the three wave lines scratched through the layer of soot which covers the cylinder. These curves are measured from a base line cut about the lower part of the record by a fourth arm of the recording instrument. They tell the observer the height of the balloon at any point in its travels, the temperature and the humidity at that point. The curves by being continuously inscribed about the cylinder during the two hours and a half of automatic observation permit inquiry into the behavior of the air at any point from the start with a close degree of accuracy.

The determination of the height is reached through the reading of the line which records the action of a barometer, giving the air pressure along the path of the balloon.

In the readings taken in the experiments at Fort Omaha the records of the Omaha office of the weather bureau are relied upon as a basis of comparison. As the barometric pressure means in general terms the weight of the air above, differences in the pressure as denoted by the curve indicate differences in elevation or the depth of the air column above the balloon.

The elevation which the balloon reached is readily computed by comparison with the pressures recorded during the flight of the balloon by a barometer at the starting point.

The failure of any of the three recording instruments to perform their functions would not mar the record of the remainder. The recording stylus of the defective instrument would instead of responding to the changes in the conditions which come within its functions would trace a string line around the cylinder. This straight line would mean, if taken literally, no change in the condition which the instrument was sent out to record. This is a well near impossible state of affairs, and hence the failure of the recorder to function would at once betray itself to the observer. However, with the barometer out of commission the record of the hydrometer and that of the thermometer would be of little value, as only through the barometer is the location of the balloon at the time of the taking of the other components of the record obtainable. Thus the air stratum in which the balloon was sailing at the time of any given temperature and degree of humidity would be left entirely a matter of conjecture without the aid of the barometric record.

For the sake of the good name of the delicate tangle of mechanism, however, it should be known that it has not yet failed to keep a continuous and accurate record.

The entire machine is constructed of aluminum, giving the maximum of strength, with a minimum of weight. The whole is enclosed in a wicker basket, to which it is attached in such a manner that the recording parts are protected from vibration and jars from sudden changes in the air currents.

The three measuring devices are subjected to an exacting series

(Continued on Page Four.)