A POLLEN-GATHERING PATENT DEDICATED TO THE PUBLIC.

Mr. E. Moulié of Jacksonville, Fla., has invented a pollen-gathering device, patents for which he has dedicated to the public for the general good. Furthermore, he will place the device at the disposal of scientific men who are interested in the gathering of pollen. The apparatus is suitable for universities and colleges, and such institutions where botany is taught.

The importance of the invention may perhaps be gaged if we consider the previous methods of gathering pollen. With the first of his machines Mr. Moulié, under the most favorable circumstances, gathered one and a half ounces of pure pollen of the ragweed (*Ambrosia Artemisiifolia*) in three days, and this with three charges of twigs, one for each day. It was the opinion of the late Prof. A. A. Curtiss, a prominent botanist, formerly connected with the Smithsonian Institution, that to collect that amount of pollen it would have taken one hundred persons thirty-six hours.

Mr. Moulié's device consists of a vessel provided with means for holding the slips or twigs bearing the blossoms from which the pollen is to be collected. The vessel is filled with water, so as to keep the twigs fresh and ripen the blossoms. The blossoms overhang the edge of the vessel, so that the pollen falls upon a paper sheet spread closely around the bottom of the vessel, which bottom is narrower than the top of the vessel, so that the paper is free to be removed without touching the vessel. The vessel or tank is made of sheet metal. Over the top of the tank is a sheet-metal plate supported over two longitudinal and two transverse rods, the edges of the plate being bent around the rods. This cover plate is smaller in area than the top of the tank, so that a narrow channel or opening is formed around the entire perimeter of the plate. The rods project across this opening, their ends being bent over the rim of the tank. Into the openings around the plate the twigs and branches are inserted, their lower limbs being immersed in water. The branches are tilted, so that their upper ends project beyond the sides of the tank. To keep them in this position, and to prevent them from sliding too far into the tank, the cover is cut at the center to form a pair of flaps, which are bent outward and engage the stems. As previously stated, the tank is surrounded by sheets of paper, on which the pollen falls as the blossom ripens. The ripening is brought about by the gradual rise of temperature in the room where the operation takes place. When desired, the water in the tank may be drawn off without disturbing the branches, through a tube connected with a stopcock near the bottom of the tank. Fresh water can be poured through an opening in the cover plate. The device renders it possible to collect the pollen of flowers in unlimited quantity in its full state of fertilizing power, a thing impossible to be sure of by the ordinary process, hitherto the only method available. The ease with which much pollen can be collected at practically no cost renders it possible to obtain a sufficient quantity for accurate and exhaustive analysis, and to add to our knowledge of that wonderful mystery of nature, the breeding of plants. Moreover, an antitoxin for diseases such as hay fever could probably be prepared from the pollen of the ragweed. If the device served this purpose alone, it would reflect considerable credit upon its inventor.

To obtain pollen from the ragweed, Mr. Moulié selected a room having a single window exposed to the east, two windows exposed to the south, and one window exposed to the west. The apparatus was charged with twigs bearing ragweed flowers which were not quite open. The charged apparatus was placed upon a table extending from one end of the room to the other, with a space of two feet between the apparatus and the walls. The vessel was filled with clean water poured in through the opening at

the top, care being taken not to spill any of the water on the flowers. The paper was then spread around the apparatus, so as to cover a sufficient space from the bottom of the apparatus to about six or eight inches beyond the perpendicular line of the top of the twigs, so that the pollen could not drop outside of the paper. The paper employed was a thick Manila brand. After the apparatus was installed, all the windows and adjacent doors were closed, and a Rochester kero-

MOULIÉ POLLEN GATHERER.

sene lamp having a burner one inch in diameter was placed on the floor. To avoid the danger of fire, the lamp was placed in a large tin can. After the lamp had been lit, the apparatus was left to itself, and the door of the room locked until the next morning.

The twigs selected must be used as quickly as possible after they are gathered. Moreover, they must be gathered in the morning before the sun is too high, but not before they are free from moisture (dew or rain). This brings the work of gathering to about noontime. After the room is opened, care must be taken in opening the doors, so as not to create a draft which might blow the pollen off the sheets upon which

it has dropped during the half day and night. The door must be closed immediately for the same reason. The temperature at that time ought to be between 85 and 88 deg. Fah. In order to gather the pollen, Mr. Moulié took one sheet loaded with it, and placed it on a table in an adjacent room, closing the connecting door between the rooms as well as the windows and other openings. The pollen was collected by means of a feather and dropped into wide mouthed two-ounce jars, similar to those in which vaseline is sold. The jars were filled to about one-half inch from the bottom. The collected pollen contains a certain amount of moisture, which must be evaporated for safe keeping. To effect this, Mr. Moulié placed the jar or jars behind the windows in the room where the apparatus was installed, and arranged them so that they touched the windows. The rays of the sun streaming through the window pane and the glass jar caused evaporation to take place in about thirty minutes. Then after shaking gently until there were no more lumps, the jars were brought into the next room, and left there for one hour before they were corked. The corks selected were of the best quality and wrapped with a fine paraffine paper, so as to effect a tight closure. Small quantities of pollen can be poured in a single jar to the height of the neck. Very few readers of this journal realize what an ounce of pollen means. Perhaps some conception of the task may be had, if one imagines the collecting of an ounce of dust from the wings of butterflies.

PHOTOGRAPHING A STAR SPECTRUM.

BY PROF. S. A. MITCHELL, COLUMBIA UNIVERSITY.

If one should go to the Sandy Hook lightship off the entrance to New York Bay, and at night should see the lights of a steamer headed for the harbor, it would be practically impossible, merely by looking at these lights, to learn how fast the steamer was approaching. A rough guess might be made by watching the lights grow gradually brighter, but it would be the roughest sort of an approximation. But the astronomer with his telescope, observing the distant stars millions on millions and millions of miles away, can tell to an absolute certainty just how fast a particular star is moving toward us or away from us, giving the motion accurately to the fraction of a mile per second. Nor is this result obtained by watching the increase or decrease in the star's light, due to its approach or recession, for the stars are so far distant that no change in their brightness would be observed in a thousand years from their change of distance alone. The measurement of a star's motion in the line of sight is one of the new fields for the astronomer, and many and valuable are the scientific results accruing from this line of work.

The writer was at the Yerkes Observatory last summer, taking part in the campaign for measuring the radial velocities of all the brighter stars that can be seen from northern latitudes, and assisting in photographing the spectra of stars with the 40-inch telescope and its attached spectrograph. And what a magnificent instrument this greatest refractor in the world is! To work with this great telescope causes a feeling akin to awe in realizing that puny man, on this infinitesimal speck in the universe, called earth, by the aid of such an instrument, is able to fathom the depths of space, and reveal the secrets of stars millions and millions of miles away. Truly, there is no science which can show the matchless power of the human mind quite so well as does the old science of astronomy, the parent of all the sciences. A view of the largest refractor in the world shows also the high degree to which engineering skill has advanced in recent years, again attesting to the close union between pure and applied science.

The observatory, presented to the University of Chicago by Charles T. Yerkes, is situated seventy-five miles from Chicago on the shores (Continued on page 495.)

The Yerkes telescope with floor raised to highest position.

Bruce spectrograph fitted to the Yerkes telescope.

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PHOTOGRAPHING A STAR SPECTRUM.

(Continued from page 485.)

of Lake Geneva, the summer home of many of the Windy City's millionaires. On high ground to the north of the lake, the observatory presents a fine appearance with its great dome to the west and two smaller domes to the east of the buildings. Passing through the main doors, one enters a fine rotunda, and going up a flight of marble steps comes into the great dome, 90 feet in diameter, and gazes on the great telescope towering aloft. One beholds a massive iron stand supporting an immense steel tube of boiler plate sixty-two feet in length, five feet in diameter at the middle, tapering to three and a half feet at either end. At the upper end of the tube is the object glass, with a clear aperture of forty inches; at the other end the eyepiece and micrometer, for viewing and measuring the planets and stars, or these may be replaced by a camera attachment for obtaining the spectra of stars, planets, or sun. The telescope tube is so long that the eye end is about thirty feet higher when an object is viewed near the horizon, than when looking at a star directly overhead. To use such a telescope, requiring as it would a long system of ladders, would be well nigh impossible, were it not for an invention of Sir Howard Grubb in making the whole observing floor an elevator. The front page illustration shows the floor at its lowest point, while another view shows the floor raised as high as possible. At Yerkes the floor, seventy-five feet in diameter, big enough to seat six hundred people, can be raised and lowered through a distance of twenty-three feet, and thus the observer when working with the telescope may keep the floor at a convenient distance below the end of the telescope, the operating power being electricity. In the front-page illustration are shown two of the four counterweights that balance the floor. An idea of the size will be obtained by remembering that the dome is ninety feet in diameter. When the astronomer wishes to observe a particular star, it is necessary to turn the slit of the dome in the direction of the star, and hence the dome must be revolved. This is ninety feet in diameter and weighs one hundred and forty tons, but again by the aid of electric motors it can be rotated at will by turning on the electric current from the rising floor.

Turning to the telescope, we find a machine of fifty-three tons in weight, wherein the movable parts weigh twenty tons. This weight the astronomer has to put in motion when he turns the telescope, yet ball bearings and the refinements of modern engineering permit him to move the great machine, using only his own physical strength. For quickly turning the telescope, electric motors are used. The telescope is set up by what is known technically as the equatorial mounting, one axis, the polar axis, in the meridian parallel to the earth's axis of rotation, the other, the declination axis, at right angles to it. Circles on these two axes give the astronomer the means of locating the star by its hour angle and declination. When the star is once in the field of the telescope, it is kept there by a clockwork mechanism driving the telescope about the polar axis at a speed exactly equal and opposite to the earth's rotation. The writer of this article has used the telescope when the thermometer stood at 26 deg. below zero Fahrenheit, and yet at this temperature the mechanism worked to perfection, which speaks wonders for the excellence of this mounting made by the well-known firm of Warner & Swasey. Indeed the professional astronomer has a hard life of it, which requires a great amount of physical endurance. In the summer nights when the temperature renders life comfortable, the nights are short, the astronomer might then be permitted to join a labor union; for he can

(Concluded on page 496.)

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Inquiry No. 9036.—Wanted, the address of the manufacturers of "Cycle Ball Bearing Suspenders."

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Inquiry No. 9056.—For manufacturers of window shades.

Inquiry No. 9057.—For manufacturers of glass and china balls, used as fixtures or ornaments on lighting rod equipment, also weather vanes for same purpose.

Inquiry No. 9058.—Wanted, firms who make machinery used for pulverizing soap-stone.

Inquiry No. 9059.—For manufacturers of flexible steel chain mail.

(Continued from page 495.)

work but eight hours. But he would be obliged to resign from the union in the winter time; for observing starts at five in the evening and continues till seven the next morning, fourteen hours without a break. And how pleasant this is with the thermometer twenty-six degrees below zero! It needs quite a deal of enthusiasm to keep one from freezing to death!

To photograph the spectrum of a star, a spectroscope or rather spectrograph is attached to the eye end of the telescope. The object glass focuses the star's light on a fine slit not more than one hundredth of an inch in width and one-eighth of an inch in length. After the light passes through this slit it passes through the collimating telescope, then through the prism or prisms which break the star's light up into its component colors or spectrum, then through the camera lens and is finally brought to a focus on the photographic plate where is obtained a photograph of the star's spectrum. Much careful thought and many refinements were necessary before the spectroscope was brought to its present great degree of precision. To mention a few of them. How is it possible to keep the great telescope tube so accurately directed to the star that its light is focused on the center of the slit one-hundredth of an inch wide, for if the light does not pass through the slit it will not fall on the photographic plate.

This was made possible by making the slit jaws of polished silver, and watching the stray light reflected from the silver jaws by combining prisms and lenses in a rather curious fashion. The observer keeps his eye at an eyepiece where he can see the star image on the slit, and causes the star image to remain centered there by using the slow motions of the telescope. The exposure necessary to make a photograph depends on the brightness of the star and may last from a few minutes to two, three, or five hours, or in some few cases to eight or ten hours. During this long exposure the temperature has probably fallen a number of degrees, and the instrument has been affected by all its parts contracting. This might result in a change in the prisms with the consequence that the photographed spectrum will not be sharp and in as good definition as it might be. To overcome these difficulties, the whole spectrograph was inclosed in a tight aluminium case lined with glass work so as to be non-conducting. Fine wires were placed inside this case. While the exposure was being made a thermometer inside the case was watched through a glass window, and if the temperature dropped, a current of electricity was turned through the wires inside the case, and kept turned on till the proper temperature was reached. Within the past year a thermostat has been introduced and the temperature is automatically kept constant. And hence while the exposure is being made the spectrograph is kept at a constant temperature, there is no change in its several parts and a sharply-defined spectrum will result. A wonderfully accurate instrument this makes leading to results of the highest degree of precision.

AN AERIAL PASSENGER RAILWAY.

(Continued from page 488.)

haulage. From the haulage cable, which is one and one-half inches in diameter, the buckets are suspended, their entire weight being sustained by two steel four-inch flanged wheels running over the stationary cable.

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(Concluded on page 499.)

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