observatories do put their clocks underground. The notable exception is Pulkova.

I invite the attention of the Bureau to Mr. Hill's report, as evidence of the spirit in which the observatory has been (and still is) criticized by outside astronomers. Malice has dictated these criticisms, to my knowledge, for thirty years. In this instance ignorance becomes a valuable accessory.

Leniency in criticism of the quality of the work thus issued is not asked nor expected. Scientific work must stand or fall on its merits. But it would be an encouragement, little to be expected, if the scientific world of this country could appreciate or acknowledge the efforts to bring up to date work long in arrears. Appreciation from abroad is not wanting, and has been gratefully acknowledged.

The passage alluded to in the second extract is the following:

Before proceeding to report upon the observations secured with the instruments I desire to invite the attention of the superintendent to the following extract from SCIENCE for January 11, 1901, page 42:

We find, also, that the total number of separate observations with the prime vertical transit was 164, less than one-half the number of nights in the year, while those with the altazimuth, used as a zenith telescope, numbered a little more than the days in the year. At the international geodetic stations the observers are expected to make about 16 double observations on every clear night.

Attention is also invited to this extract from the same publication, but of the date of January 4, 1901, page 4:

There are also intimations that something is wrong with the prime vertical transit, and altogether the impression made on the reader is that, after seven years of effort to equip the observatory with the best instruments, it is doubtful whether a single one of real importance, except the great telescope, is in order for first-class work.

The writer of these editorials in SCIENCE clearly indicates that his conceptions of the amount of astronomical observing to be obtained with an instrument in the prime vertical are absurd.

This betrays a misconception so singular that we must correct it. In our strictures of want of continuity we expressly excepted the work with the prime vertical transit, which has been pursued with rare zeal and diligence. The passage first quoted from our columns was intended only to show the difficulty that readers might feel in reconciling it with the following striking statement in the report for 1900, which was given a place of honor both there and in the report of the Bureau:

All the astronomical instruments of the observatory have been steadily and continuously in use during the year on every clear night and day.

In energetically showing that the instrument was out of use from April till June, Mr. Hill only impugns the accuracy of this statement, not the correctness of our remarks, which were mere condensations from the observatory report.

The intimations of our second extract comprised allusions to 'a systematic error whose origin still remains a mystery,' and reported efforts to locate this error found in the publications and reports of the observatory. Our 'grave doubts' may be justified by the facts now reported that three other instruments have been undergoing alterations and repairs since we wrote.

A statement has appeared in the public prints that the head of the observatory will reply to the board of visitors. If this is done SCIENCE will be glad, in the interest of fairness and justice, to bring into prominence whatever he can say in defense of his position.

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*REPORT OF THE SUPERINTENDENT OF THE NAVAL OBSERVATORY.**

THE 26-INCH EQUATORIAL TELESCOPE.

THIS instrument has been in charge of Professor T. J. J. See during the whole year. Owing to the death of Mr. George

* Condensed by omitting passages of less general interest than the rest.—EDITOR.

Anderson, who had been assistant on this instrument for twenty-six years, which occurred in November last, and to the absence after February 1 of the party sent out by the observatory to observe the eclipse of the sun in Sumatra, Professor See worked entirely alone for a part of the year. The manual labor alone in using this instrument is considerable, and I consider the showing made in Professor See's report as creditable. This instrument has been devoted to the same general line of work as in previous years, and has been maintained in good order. Professor See's report is herewith transmitted.

THE 9-INCH TRANSIT CIRCLE.

This instrument has been steadily employed on the regular sun, moon, and planet work, a revision of the Astronomische Gesellschaft Zones, and the Zone of Zodiacal Stars undertaken for the Paris Astronomical Conference of 1896. From long service this instrument is in need of important repairs. The pivots have become so worn as to need regrinding, and the illumination should be changed so that the reticule will be illuminated by a beam of light in the optical axis of the instrument, instead of a beam cast from one side, as at present. As soon as the alterations of the 6-inch transit circle, which are noted later, are completed, the whole staff for meridian observations will be transferred to that instrument, and the 9-inch transit circle will be put under repairs. The report of Assistant Astronomer King, in charge of the instrument at the close of the fiscal year, is transmitted herewith.

THE 6-INCH TRANSIT CIRCLE.

Since this instrument was mounted two years ago a serious defect in the form of a diurnal change in the constant of azimuth, following changes of temperature, has been a source of annoyance and embarrassment and a serious detriment to the usefulness of the instrument. Since March last a systematic and patient investigation of this defect has been carried on by Professor Updegraff with the object of determining, and if possible, removing the cause. Successive changes have been made in the instrument and its supports as a result of this investigation, without in any way altering its form (which could not be done without entirely rebuilding it), and there is reason to believe that the success of these changes is already assured.

This instrument was built by Messrs. Warner & Swasey, of Cleveland, Ohio, from designs by Professor William Harkness, U. S. N., following closely the pattern of the latest instruments by Repsold, of Hamburg. It would be presumptuous to criticise the result of the experience of the oldest and most skilful instrument-makers in the world, and yet I can not believe that this form of instrument will ever be entirely free from uncertainty in the errors of azimuth or level, or both, for the reason that in order to assure precision in other respects a principle has been sacrificed which has been recognized as fundamental in the construction of astronomical instruments for at least two hundred years, viz., that the instrument itself should be directly supported on a substantial foundation of masonry. In this form of instrument the pivots are supported by a skeleton work of metal by which they are raised sixteen inches above the piers. Differences in the rate of expansion between the masonry of the piers and the metal support of the pivots become immediately apparent in the azimuth or level of the instrument, and some evidence of this will, I believe, be always apparent. If these errors can be reduced to something manageable under normal conditions, there will still remain the probability that abnormal conditions and sudden and excessive changes of temperature may still make them incon-

veniently apparent. In this connection I may observe that preparations have been made for a south meridian mark for both the 6-inch and 9-inch meridian circles, but no steps have been taken during the year to erect them.

THE CLOCK SYSTEM.

The effort to bring the department of meridian observations, which is the real *raison d'être* of the Observatory itself, to a state of the highest efficiency and up to the most modern standard of requirement, has included not only a thorough overhauling of both meridian instruments, but also an examination, and if possible an improvement in the clock system of the Observatory. Critics who are in no way responsible for results, and who probably would not carry out their own suggestions if they were, have had a standing grievance against the Observatory because it has not put its clocks underground. In point of fact very few observatories do put their clocks underground. The notable exception is Pulkova. It is difficult to maintain a clock underground and not ruin it by rust. The experiment was tried in the very early days of the Naval Observatory and abandoned after the valuable Kessels clock had been nearly sacrificed to the experiment. If, however, a clock can be inclosed in air-tight case from which the air has been partially exhausted, it should be entirely removed from the influences of temperature, pressure and humidity, and it should, theoretically, be as safe in a vault as above ground. This is the principle which has governed the construction of the clock vault of the Naval Observatory. The vault is dug in the basement of the clock house, which stands on the highest eminence in the Observatory grounds, a knoll of quite abrupt grades, of a gravel soil, and so situated that the natural drainage is away from the vault in all directions. The vault is built with double walls and roof and thick concrete floor, the space between the walls being filled with nonconducting material. The air of the vault is dried by gas and proper provision is made for ventilation. The air-tight cases containing the clocks are of metal and glass, and in each is exposed in full view a rust gauge of bright steel, which is closely watched, and its condition reported to the Superintendent at frequent intervals. The Kessels clock, which is regarded as the standard, is regulated to mean time, and as it is not capable of sustaining the electrical connections necessary for chronometric connection on the clock circuit, it is compared with the sidereal sounder by coincidence of beats by the aid of a microphone, the beats of the clock being wholly inaudible to the unaided ear. So far the whole arrangement has proved on the whole satisfactory, and the rate of the Kessels clock reduced to a constant of almost 0. Some trouble has been experienced in making the clock case actually air-tight, and if the experiment (for I regard it as no more than an experiment) fails, it will be from this cause. Professor Updegraff's report is herewith transmitted.

THE 12-INCH EQUATORIAL.

This instrument has undergone extensive alterations during the year. It was remounted in April, and has been employed in charge of Assistant Astronomer Theo. I. King, since that time. This instrument is used for the benefit of visitors admitted to the Observatory at night.

THE PRIME VERTICAL TRANSIT INSTRUMENT AND 5-INCH ALTAZIMUTH.

These instruments have remained in charge of Assistant Astronomer G. A. Hill, in continuation of the observations for variation of latitude.

I invite the attention of the Bureau to Mr. Hill's report, as evidence of the spirit in which the Observatory has been (and

still is) criticised by outside astronomers. Malice has dictated these criticisms, to my knowledge, for thirty years. In this instance ignorance becomes a valuable accessory.

THE 40-FOOT PHOTO-HELIOGRAPH.

Photographs have been taken of the sun daily whenever the weather and other circumstances would permit. During the absence of the photographer, Mr. George H. Peters, on duty with the eclipse expedition, his place was supplied by Mr. E. A. Boeger, computer.

THE TOTAL SOLAR ECLIPSE OF MAY 18, 1901.

By virtue of a provision of the urgency deficiency bill of the last session of Congress, the Observatory was enabled to equip and put in the field an expedition to the island of Sumatra to observe the total eclipse of the sun of May 18, under charge of Professor A. N. Skinner, U. S. N. Professor Skinner's very interesting preliminary report of the expedition and its results is forwarded herewith. A detailed report will appear in conjunction with a report of the eclipse of May 28, 1900, in a forthcoming volume.

It may very reasonably be asked whether, in view of the meager results on account of cloudy weather on the day of the eclipse, the expense of sending an expedition to such a distance was a justifiable outlay of public money. The reply would be that a chance of failure on account of the weather was one of the conditions which attached unavoidably to the undertaking. Other expeditions were less fortunate and secured no results at all. But the real answer is that results, no matter how meager, fully justify the outlay, because such results are not to be judged by themselves, but are to be regarded as forming a part of the general sum of observations of this and other eclipses. The problems presented will be solved, not by the recorded observations of any one person at any one time, but by the accumulation of such observations in the general account of human knowledge. From this point of view even one photograph, or a single observation of contact, would have fully justified the entire outlay. At Fort de Kock ten excellent negatives were obtained, which were acknowledged by foreign astronomers to be the best made by any party in the field, and at Solok, the Observatory's other station, contacts were observed and some photographs obtained. I am satisfied with the results.

A serious drawback to the expedition has been the withdrawal for so long a period of an important part of the Observatory's astronomical staff.

An acknowledgement is due the War Department for uniform courtesy to the expedition both on board the transports and at Manila, and to the commanding officer of the U. S. S. *General Alava* for much valuable assistance.

COMPUTATIONS AND PUBLICATIONS.

Since my last report the whole computing force of the Observatory has been assembled in one division, instead of being distributed to the various instruments as heretofore. This change has resulted in a decided economy of time and labor, and is generally in the interests of system and efficiency. All astronomical observations, by whomsoever made, are turned over to the computing division for reduction, it being understood that the author is consulted as to the methods of reduction and exercises a general supervision in cooperation with the officers at the head of the division. Professor Eichelberger has been placed in charge of this division, and in his absence with the Sumatra eclipse expedition his place was supplied by Assistant Astronomer King, up to the close of the fiscal year.

During the year the first volume of the new series of Washington Observations has

been published and distributed. The second volume is ready for the press and will be printed immediately. A third volume is nearly ready, and other volumes will follow as rapidly as the material can be prepared for the printer, and until the accumulation of unpublished work is exhausted. This breaks the long suspension of printing which has been a source of anxiety for several years. Leniency in criticism of the quality of the work thus issued is not asked nor expected. Scientific work must stand or fail on its merits. But it would be an encouragement, little to be expected, if the scientific world of this country could appreciate or acknowledge the efforts to bring up to date work long in arrears. Appreciation from abroad is not wanting, and has been gratefully acknowledged.

NAUTICAL ALMANAC OFFICE.

Professor W. S. Harshman was appointed Director of the Nautical Almanac March 28, 1901. Up to that time and since the retirement of Professor Simon Newcomb the direction had been in the hands of a professor of mathematics who held the post in addition to his regular duties at the Observatory. The Almanac demands the undivided time and attention of a competent director. This need had become imperative. Professor Harshman has had the advantage of long experience in the office in a subordinate capacity. He has systematized and regulated the office and brought the work up to date, the regular issue of the Almanac three years in advance having failed. The office is now in a high state of efficiency, and general harmony and enthusiasm prevail in its staff. The Nautical Almanac has been noted, since its foundation in 1849, for thoroughness and precision in its methods and for superior excellence in its personnel. That this quality is still dominant is shown by the high stand taken by several of its staff in the competitive examinations for professorships. The report of the Director of the Nautical Almanac is herewith transmitted.

THE BOARD OF VISITORS.

The Board of Visitors established by the naval appropriation act approved March 3, 1901, which went into effect on July 1, met in April, and since that time and prior to July 1, two duly constituted committees of the board have visited the Observatory officially. The law provides for one 'annual visitation to the Observatory at a date to be determined by the Secretary of the Navy, and * * * such other visitations, not exceeding two in number annually, by the full board or by a duly appointed committee as may be deemed needful or expedient by the majority of the board.' The board has already made the full number of visits allowed by law to any one year.

THE DEPARTMENT OF NAUTICAL INSTRUMENTS AND GENERAL STORE-KEEPER AND DEPARTMENT OF CHRONOMETERS AND TIME SERVICE.

By the detachment of Lieut. Commander Charles E. Fox in May, the last remaining officer of these departments was withdrawn, and both of these important departments left without any regularly assigned personnel whatever. The regulations for the government of the Observatory issued by the Department provide for three officers for this work. I believe this situation is unique in the public service. It is hard to make bricks without straw, but that is the situation of these departments at the present time.

As the work could not cease, a computer, previously detailed from the astronomical department has been put in charge of these departments, with one of the clerks of the Observatory in charge of the books. This arrangement is not only improper, but is prejudicial to the service and injurious to

the individual. I have in previous reports made specific recommendations looking to the establishment and maintenance of a permanent force for these departments. I renew these recommendations. The accompanying reports show the volume of business in these departments for the year.

THE PRIME VERTICAL TRANSIT AND THE ALTAZIMUTH.

Sir: In compliance with paragraph twenty three of the regulations governing the United States Naval Observatory, I respectfully submit the following report of the operations in my department during the year ending June 30, 1901.

Before proceeding to report upon the observations secured with the instruments I desire to invite the attention of the superintendent to the following extract from SCIENCE for January 11, 1901, page 42:

"We find, also, that the total number of separate observations with the prime vertical transit was 164, less than one-half the number of nights in the year, while those with the altazimuth, used as a zenith telescope, numbered a little more than the days in the year. At the international geodetic stations the observers are expected to make about sixteen double observations on every clear night."

Attention is also invited to this extract from the same publication, but of date January 4, 1901, page 4:

"There are also intimations that something is wrong with the prime vertical transit, and altogether the impression made on the reader is that, after seven years of effort to equip the observatory with the best instruments, it is doubtful whether a single one of real importance, except the great telescope, is in order for first-class work."

The writer of these editorials in SCIENCE clearly indicates that his conceptions of the amount of astronomical observing to be obtained with an instrument in the prime vertical are absurd.

Taking up the first extract, I wish to answer it. I was, by orders of the Department, as well as by yourself, detailed last spring as an observer in one of the parties sent south to observe the eclipse of the sun, and for six weeks I was detached from the instrument.

From April 15 to May 1, I was directed to give my whole time to preparing for shipment the apparatus to be used in the eclipse. From May 1 until June 1, 1900, I was at Griffin and Barnesville, Ga., engaged in preparing for the phenomena just mentioned. In addition, I observed at both places on fifteen nights, to determine their latitude and longitude.

The wisdom of the Observatory displayed in having those two fundamental positions determined is well illustrated by the misfortune that came to an observer who went to Africa. He trusted to an approximate latitude and longitude, and found at the instant of the eclipse he was entirely outside of the shadow line.

If the writer of the above extract was only superficially informed of the time necessary to secure a complete observation of a star across the prime vertical, he would not have attempted to make a comparison between the number of observations secured during the same period with the prime vertical and the zenith telescope. It will take about four hours per night to observe sixteen pairs of stars with the zenith telescope, the number usually obtained by those engaged in the variation of latitude work. In the same time it is impossible for anyone using the prime vertical to secure more than four or five, and had the writer consulted an astronomer he would have found that out.

During the past spring I observed practically all night on each in which the sky was clear, and over a tour of observing of

nine or ten hours the largest number of star observations I could possibly obtain was nine or ten.

As an additional answer to his senseless criticism, I would invite the attention of the superintendent to a comparison of the number of observations made with our instrument with that obtained by the only other astronomer who is now continuously observing with the prime vertical transit.

In 1900 I obtained in ten and one-half months observing 164 observations. The observer at Pulkova for the full year made 106. Since 1896 I have secured 1,150 observations. In the same time the prime vertical at Pulkova has yielded 755. This record will be found in Professor Albrecht's report on the variation of latitude for 1900, a copy of which is in the library.

The remarks contained in the second extract are equally absurd.

In justice to our prime vertical transit, I desire here to state that it is of a better form, it is built in a more symmetrical manner, and its mounting permits of determining the errors it may have in a more complete manner than any other now in use.

In 1898 I obtained about 125 observations of α Lyræ in the full daylight, as well as in the night. The range between the greatest and least declination for the whole year's work, including every observation made, and the good, fair, and poor seeing that obtained for each, was 1.44″. If four observations are rejected, because they stand out so markedly from the others, made at a time when the seeing was very poor, and so noted in the observing book, the range is reduced to 1.04″.

There is not in existence a meridian circle, vertical circle or zenith telescope that has been used to observe the same star or pair of stars, *throughout the year*, that has as small a range as that in the declination, or latitude secured with it. The probable error of a single observation for that series, including the variation of latitude, is ± 0.16″.

I have during the year made an investigation of the form of the two pivots attached to the instrument. I have examined each throughout the length of its bearing surface in the Y's, and the results, which will be printed in the volume containing the observations secured with the instrument, do not indicate that either pivot is out of parallelism with the cube, or that their departure from a true cylinder is of enough magnitude to affect an observation.

In the past year I have made 619 observations with the aid of both instruments. The reduction of the observations on the sheets, which have all been made by myself, are practically complete to the 1st of January, 1901.

Last fall I made a complete rediscussion of the prime vertical transit observations, basing the derived latitude upon the star places obtained from the New Catalogue of Fundamental Stars, prepared by Professor S. Newcomb. After it was finished the results were transmitted to Professor Albrecht, of the Central Bureau der Internationalen Erdmessung, Potsdam, Germany, to be used by him in his annual paper upon the 'Variation of Latitude.'

From that discussion the following mean yearly latitudes were obtained:

	°	′	″
1894	38	55	14.51
1895			.52
1896			.61
1897			.46
1898			.45
1899			.43
1900			.55
Mean	38	55	14.50
Reduction to the clock room			—.52
Latitude of Naval Observatory	38	55	13.98

The individual observations of all prime vertical transits up to December 31, 1899, are now ready for the printer. The intro-

duction to the volume to contain them is three-fourths completed, and will be finished in time to transmit it to the Government Printing Office by the last of July or middle of August.

The 5-inch altazimuth was used during the year principally as a zenith telescope, in connection with the prime vertical transit. I am not making zenith-telescope observations exclusively with it, but only of those stars that are observed with the prime vertical, and which permit of being observed by Talcott's method.

This observatory is the only one in this country equipped with a prime vertical transit and for that very reason the major portion of the data we are securing for the study of the variation of latitude is made with it.

George A. Hill,
Assistant Astronomer.

ANNUAL REPORT OF THE SECRETARY OF AGRICULTURE, 1901.

The Fifth Annual Report of the Secretary of Agriculture, Hon. James Wilson, is considerably longer than in former years, reflecting thereby the great growth and development which has attended this Department during his administration.

WEATHER BUREAU.

He announces an important extension of the forecast field of the Weather Bureau, which now includes reports from certain points in the British Isles and on the continent of Europe, from the Azores, Nassau, Bermuda and Turks' Island. The Atlantic forecasts based upon these reports now form part of the regular night forecasts issued in Washington. Three new forecast districts have been established—in Boston, New Orleans and Denmark. An extension of the forecast to farmers through the Rural Free Delivery is contemplated. Substantial improvements are reported in the Department's system of wireless telegraphy, of which the Secretary states in conclusion:

> While there is much experimental work yet to be done before the present system is reliable for intership communication, or before any two systems can work within the same field without each rendering the other useless, such progress has been made by the Government experimenters that, with no interference by private systems, stations can be successfully operated over at least 150 miles of coast line, and they are now in operation on the North Carolina and Virginia coasts, and soon will be instituted between the Farallone Islands and the mainland and Tatoosh Island and the mainland, on the Pacific coast.

ANIMAL INDUSTRY.

A large portion of the report covers the subject of animal industry. The grand total of animals and animal products exported during the year exceeded $250,000,000 in value. This vast foreign market is only preserved to our producers by the indefatigable efforts of the Department and the rigid inspection exercised through the Bureau of Animal Industry. This Bureau inspected for export 385,000 cattle, 228,000 sheep and 48,000 horses and mules, and nearly 1,000 vessels carrying live-stock. Imported animals were also inspected to the number of 342,000, and, where necessary, quarantined. The Secretary suggests that with the enormous interests our stock-raisers have at stake, and inspection or quarantine affording, after all, a relative, not an absolute guarantee of protection, it might be well for this country to follow the example of Great Britain and exclude live-stock from other countries entirely. The meat-inspection service involved the inspection at time of slaughter of nearly 37,000,000 animals. Of the more than 5,000,000 cattle inspected, the condemned carcasses were about one-fourth of 1 per cent.; of the 6,500,000 sheep, one-tenth of 1 per cent.; and of 24,000,000 hogs, one-third of 1 per cent. In the control of indigenous diseases, 1,500,000 inspections were made and over 45,000 cars disinfected in the Texas fever