shown was to be shipped, when completed, to General Coxey, the leader of the famous "Coxey Army," which marched to Washington last year.

This is an example of one of the heavier machines produced, others running as high as 45,000 pounds each. The general view of the main shop shows a very complete plant and indicates the great facilities possessed by the company for work of the heavier class.

Scientific American.

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Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

No. 1013.

For the Week Ending June 1, 1895.

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THE BERLINER TELEPHONE DECISION.

It seldom falls to the lot of the federal government to appear so conspicuously in the courts as it has within the last few days and to accept in succession two such important and far-reaching defeats as those it has suffered in the income tax decision before the United States Supreme Court and in the Berliner patent decision in the United States Circuit Court of Appeals. It is not long since we noted in these columns the decision rendered by Judge Carpenter in the Circuit Court, in the suit brought by the government to annul the Berliner patent. The decision declared the patent to be invalid; it was based on the ground of wrongful delay in procuring the issue of the patent, in implying a want of diligence on the part of the applicant, all which seemed to afford a most equitable ground for declaring the patent invalid.

The second ground was more of the statutory class, referring to the issue of a prior patent to the same applicant for the same invention. On the 18th of May the United States Circuit Court of Appeals, to which the case had been brought on appeal by the Bell Telephone Company, reversed the decision of the Circuit Court, but allowed the appellee, which is the government, to file a motion as to the form of the judgment to be entered with a brief in support of the same. The decision, while a great triumph for the Bell Company, is somewhat tempered by this last clause, as the government has on file a motion to amend the bill so as to allege a tacit understanding with the officials of the Patent Office in the matter of the delay of the Berliner patent, which, if proved, would go to show possibly an absolute fraud. The case cannot be fully discussed until the rendering of the opinion of the Circuit Court. The United States will carry the case to the Supreme Court.

THE HEAVENS IN JUNE.

The planetary maneuvers in the evening sky during June will be not less attractive than they were in May. Mercury will not only be visible after sunset during the first half of the month, but that shy planet will perform an exceedingly interesting evolution with Jupiter. On the first of June Mercury will be seen about 6° west, or on the sunward side, of Jupiter. But, in consequence of its more rapid motion eastward, it will approach the giant planet, gaining about three-quarters of a degree upon the latter every day, and on the 8th will overtake it, passing on the north at a distance of only 47′. The nearest approach will occur at 10 o'clock in the morning. Afterward Mercury will continue to forge ahead of Jupiter until the afternoon of the 18th, when it will turn back and begin a rapid flight sunward, meeting and passing Jupiter on the south at a distance of 2° 34′ at 9 P. M. on the 21st. Then it will again distance its great competitor until it disappears in the solar rays.

Jupiter itself practically passes off the stage this month, getting too near the sun at the close to be well seen. It is still in the constellation Gemini.

Mars will remain in view a little longer than Jupiter, but the ruddy planet has moved so far away in its orbit that it no longer possesses any special interest as a telescopic object, while for the naked eye it has sunk into comparative insignificance. The question whether Mars has or has not an atmosphere sufficient to support life resembling that of the earth has not yet been settled to the general satisfaction of the disputants. Mars passes from Gemini into Cancer early in the month and continues in the last named constellation during the remainder of June.

Venus, which so completely outshone Jupiter during May, will grow still brighter in June. There is an education in the science of light in a study of the causes which make a planet less than 8,000 miles in diameter appear so much brighter than a planet more than 86,000 miles in diameter. The primary cause is, of course, the comparative nearness of the former to the sun and to the earth. Venus, seen with the telescope, will be very near the half-moon phase at the end of the month. She is moving eastward and southward and will be in conjunction with Mars on June 5th at 5 o'clock in the morning. From Gemini she passes on the 5th into Cancer, and from Cancer on the 25th into Leo.

Neptune in Taurus is too near the sun to be observed.

Saturn, remaining in Virgo, some 10° almost directly east of Spica, is the most attractive planet on the list for telescopic observation. The smallest telescope worthy of the name suffices to reveal the principal charm of Saturn, the wonderful system of rings suspended above its equator. It gives the observer a picturesque sense of the enormous distance across which he is looking to recall, while his eye is at the telescope, the fact that those rings measure almost 170,000 miles from end to end of the elliptical figure which they present. There is no lack of exhibition space in the solar system.

The spectroscopic discovery, made by Professor J. E. Keeler, of the Allegheny Observatory, that the rings of Saturn actually consist—as Maxwell long ago mathematically proved that they must do—of swarms of small satellites or meteorites, is one of the finest of recent achievements in practical astronomy. Professor Keeler's proof, which is wonderfully interesting as well as convincing, consists in photographs of the spectrum of the planet and its rings, which show the spectral lines displaced in such a way as to indicate that the inner edge of the ring system revolves around the planet nearly a mile and a quarter in a second faster than the outer and nearly two miles and a quarter faster than the outer edge. The movements of the various parts of the system as thus ascertained agree satisfactorily with the velocities that satellites revolving around the planet at corresponding distances should have according to Kepler's third law of planetary motion.

Uranus remains near the star Nu in Libra and some 3° nearly east of Alpha Libræ. It is about equal in brightness to a star of the sixth magnitude and can consequently be seen with the naked eye. It may be recognized with the aid of a field glass by noticing for several nights in succession its position with reference to small stars near it. If careful charts are drawn of the field of view, the motion of the planet will soon become manifest, and such an exercise is good discipline for a beginner in stellar observation.

June opens with the moon just past first quarter in Virgo. The moon fulls at 6 o'clock on the morning of the 7th in Sagittarius, reaches last quarter in Pisces at 6:28 A. M. on the 15th and becomes new moon in Gemini at 4:51 P. M. on the 22d. The second moon of the month reaches first quarter at 1 minute past 9 o'clock on the morning of the 29th, when it will be in Virgo, about 8° west of Spica.

The moon visits the planets in June as follows: Saturn on the 4th, at 12:58 A. M.; Uranus on the 5th, at 2:56 A. M.; Neptune on the 21st, at 4:33 P. M.; Mercury on the 23d, at 12:14 P. M.; Jupiter on the 23d, at 1:43 P. M.; Mars on the 25th, at 6:27 A. M.; and Venus on the 25th, at 11:11 P. M. This last will be a comparatively close conjunction.

The astronomical summer begins at noon on the 21st.

Among telescopic objects for amateurs that will be well situated for observation this month (in addition to those described last month which still remain in view) are the following:

The great star cluster, M 13, in Hercules. This is an impressive object even when seen with only a 3 inch or 4 inch telescope. Those who have 4½ or 5 inch telescopes may try them upon the binary star Zeta Herculis. The distance of the components at present does not exceed a second and a quarter.

More interesting to the ordinary star gazer in search of the picturesque, and easy to divide with a 3 inch glass, is Alpha Herculis. Here a striking contrast of color will be noticed, the larger star being orange and the smaller emerald green. The distance is about 4½ seconds. Rho Herculis, whose components are nearly a second closer than those of Alpha, shows the combination of a white with a green star. Still another interesting double in Hercules is the star 95, whose two components are 6″ apart, the larger being green and the smaller red.

A good 4½ inch telescope, and sometimes even a smaller aperture than that, will show the celebrated companion of the great red star Antares in Scorpio. The distance is three seconds, and the color of the little companion is a vivid green. This is one of the finest sights among the double stars. While surveying Scorpio the observer should not neglect to look at Beta, a very easy double, which also exhibits a contrast of colors. The larger star is white and the smaller blue, the distance being about thirteen seconds. Its neighbor Nu is a fine triple, with which a 4 inch glass, or even a 3½ inch, is easily capable of dealing. The two nearest stars are about a second and three-quarters apart; the farthest star is distant forty seconds. For a beautiful combination of orange with blue look at the star 39 Ophiuchi. The components are twelve seconds apart, so that even a 2 inch glass will separate them.

As remarked last month, these objects cannot be readily found without the aid of a star atlas, a book that ought to stand next to the dictionary in all households where intellectual recreation is favored.

GARRETT P. SERVISS.

THE MOON'S STORY.*

BY SIR ROBERT BALL, LOWNDEAN PROFESSOR OF ASTRONOMY AND GEOMETRY AT CAMBRIDGE, ENG. FORMERLY ROYAL ASTRONOMER OF IRELAND.

I do not think there is any chapter in modern science more remarkable than that which I here propose to describe. It has, indeed, all the elements of a romance. I am to sketch an event of the very greatest moment in the history of this universe, which occurred at a period of the most extreme antiquity, and has been discovered in the most remarkable manner.

The period of which I write is far more ancient than that of the Pyramids of Egypt, or of any other monuments erected by human effort. It is even more early than that very remote time, hundreds of thousands of

* Communicated to the SCIENTIFIC AMERICAN by the author.

years ago, when man himself first came upon this globe. Our retrospect has to pierce right through those vastly protracted cycles which the geologists have opened up to us. We speak of a period long anterior to the ages during which our continents were being sculptured into their present mountain chains and river courses. We have to look through those periods still earlier, when great animals, long extinct, flourished on this earth. The time of which I write is more remote than that very remarkable epoch in earth history during which the great coal forests flourished. It is earlier than the supreme moment, countless millions of years ago, when living organisms first became inhabitants of this globe. Even here, however, our retrospect must not stop. We have yet once more to look back through certain anterior periods to a time when our earth was in its earliest youth. The chapter of history about which I am now writing is indeed in the very dawn of things terrestrial.

It might be thought that it would be utterly impossible for us to learn anything with regard to what took place at a time so immeasurably anterior to all sources of tradition, and indeed to all the ordinary channels for obtaining knowledge by observation. It however fortunately happens that the darkness of this early period is illumined by a bright and steady source of light which will never deceive us if only we will follow it properly. Our trustworthy guide is to be the pen of the mathematician, for it is well known that, unless we are going to dispute the fundamental proposition that two and two make four, we cannot impugn the truths which mathematics discloses. This science knows no boundaries of space. It recognizes no limits in time. It is ever ready for discussing operations which take place either in the millionth part of a second or in the lapse of uncounted millions of centuries. The processes of mathematics are alike available for tracing out the delicate movements in the interior of a molecule not one millionth part of the size of a grain of sand or for investigating the properties of space so vast that the whole solar system only occupies an inconsiderable point by comparison. Let us therefore see what this infallible guide has to teach us with regard to that momentous epoch in the history of our system when the moon was born.

Our argument proceeds from an extremely simple and familiar matter. Every one who has ever been on the sea shore knows the daily ebb and flow of the waters, which we call the tides. Long ere the true nature of the forces by which the moon acts upon the sea was understood, the fact that there was a connection between the tides and the moon had become certainly known. Indeed, the daily observation of a fisherman or of any one whose business was concerned with the great deep would have taught him that the time of high water and the time of full moon stood at each place in a certain definite relation. The fisherman might not have understood the precise influence of the moon upon the tides, but if he had observed, as he might in some places, that when the moon was full the tide was high at 10 o'clock in the morning, it would be perfectly obvious to him that the moon had some special relation to this ebbing and flowing of the ocean. Indeed, we are told of some savage race who, recognizing that the moon and the tides must be associated, were still in some considerable doubt as to whether it was the moon which was the cause of the tides, or the tides which were the cause of the moon.

The ebbing and flowing of the tide opens up this chapter in remote history, which we can now explore, mainly by the help of the researches of Prof. George Darwin. For, as the tides course backward and forward, sweeping to and fro vast volumes of water, it is obvious that the tides must be doing work. In fact, in some places the tides have been made to do useful work. If the water as it rises be impounded in a large reservoir, it can be made to turn a water wheel as it enters, while another water wheel can be driven as the reservoir empties itself a few hours later. Thus we produce a tidal mill. It is quite true that, so long as coal remains tolerably cheap and steam power is consequently readily available, it is not often possible to employ the direct power of the tides in an economical manner. For our purpose it is merely necessary to note that, day after day, week after week, year after year, the tides must be incessantly doing work of some kind or other.

Every practical man knows that a certain quantity of work can only be done by the expenditure of a certain quantity of energy. He also knows that there is in nature no such thing as the creation of energy. It is just as impossible to create out of nothing the energy which should lift an ounce weight through a single inch as it would be to create a loaf of bread out of nothing. If, therefore, the tides are doing work, and we have seen that they undoubtedly are doing work, it follows that there must be some source of energy on which the tides are enabled to draw. A steam engine is able to put forth power because of the energy developed from the coal which is continually supplied to the furnace. But where is the equivalent of the coal in the great tidal engine? We might at first hazard the supposition that, as the moon is the cause of the tides, so we must look to the moon to provide the energy by which the tides do their work. This is, however, not exactly the case. The match which lights the fire under a steam boiler is in one sense no doubt the cause of the energy developed; but we do not, therefore, assert that the power of the engine is derived from the match. It comes, rather, from the fuel whose consumption is started by the match. In like manner, though the moon's attraction causes the tides, yet it is not from the moon that the tidal energy is drawn. There is only one possible source for the energy necessary to sustain the tides. Every one who is conversant with mechanical matters knows the important duty which the flywheel performs in a mill. The flywheel, in fact, may be considered as a reservoir into which the engine pours the power generated with each stroke of the piston, while the machinery in the mill draws on this accumulated store of power in the flywheel. If the engine is stopped, the flywheel may yet give a turn or two, for the energy which it contains may be still sufficient to drive for a few seconds the machinery through the mill. But the store of energy in the flywheel would necessarily become speedily exhausted and the flywheel come to rest unless it were continually replenished by the action of the engine.

The earth may be regarded as a mighty flywheels which contains a prodigious store of energy. That energy is, however, never added to, for there is no engine available. If, however, no energy were withdrawn from the earth, then the globe would continue to spin round its axis once every twenty-four hour, forever. As however the tides need energy to get through their work, they abstract what they require from the store which they find at hand in the rotation of the earth. Next time you see the tides scouring up and down a river you may reflect that the power which impels that mass of water to and fro has been obtained solely at the expense of the spinning of our globe. Indeed, the little child who digs a moat in the sand, which is filled by the rising tide, affects, to a certain extent, the revolution of this earth about its axis.

This withdrawal of energy from the earth is incessantly taking place along almost every coast. From day to day, from century to century, from æon to æon, energy is daily being withdrawn and daily wasted, never again to be restored. As the earth has no other means of replenishing its stores, the consequence is inevitable. The quantity of energy due to the rotation of the earth must be gradually declining. Stated in this way, perhaps the intimation is not very alarming, but, placed in other words, the results at which we have arrived assume the more practical expression that the tides must be gradually checking the speed with which the earth turns round. The tides must, in fact, be increasing the length of the day. In consequence of the tides which ripple to and fro on our shores, and which flow in and flow out of estuaries and rivers, to-day is longer than yesterday, and yesterday is longer than the day before. I may, however, admit at once that the change thus produced is not very appreciable when only moderate periods of time are considered. Indeed, the alteration in the length of the day from this cause amounts to no more than a fraction of a second in a period of a thousand years. Even in the lapse ordinary history, there is no recognizable change in the length of the day. But the importance of our argument is hardly affected by the circumstance that the rate at which the day is lengthening is a very slow one. The really significant point is that this change is always taking place, and lies always in the same direction. It is this latter circumstance which gives the present doctrine its great importance as a factor in the development of the earth-moon system.

We are accustomed in astronomy to reason about movements which advance for vast periods in one direction, and then become reversed. Such movements as this are, however, not the real architects of the universe, for that which is done during one cycle of years is undone during the next. But the tides are ever in operation, and their influence tends ever in the same direction. Consequently the alteration in the length of the day is continually in progress, and in the course of illimitable ages its effects accumulate to a startling magnitude.

The earth now revolves on its axis once in twenty-four hours. There was a time, millions of years ago, very likely, when it revolved once in twenty-three hours. Earlier still it must have spun on its axis in twenty-two hours, while this succeeded a time when the day was only twenty hours. The very same arguments applied in those times which apply at the present, so that if we strain our vision back into the excessively remote past, we find the earth spinning ever more and more rapidly, until at last we discern an epoch when the length of the day, having declined to eight hours and seven hours, had at last sunk to something like five or six hours. This is the time when the moon's story commences. At this eventful period the earth accomplished about four revolutions in the same time that it now requires for a single one. We do not attempt to assign the antiquity of this critical moment. It must certainly have been far earlier than the time when this earth became fitted for the reception of organized life. It must have been at least many millions of years ago. If it be thought that the vagueness of our chronology is rather unsatisfactory, then it must be remembered that even historians who have human records and monuments to guide them are still often in utter uncertainty as to the periods during which mighty empires flourished, or as to the dates at which great dynasties rose or perished.

But our story has another side to it. Among the profoundest laws of nature is that which asserts that action and reaction are equal and opposite. We have seen that the moon is the cause of the tides, and we have further seen that tides act as a brake to check the speed with which the earth is rotating. This is the action of the moon upon the earth; and now let us consider the reaction with which this action must be inevitably accompanied. In our ordinary experience we observe that a man who is annoyed by another feels an unregenerate impulse to push the annoying agent away as far as possible. This is exactly the form which the reaction of the earth assumes. It is annoyed by the moon, and accordingly it strives to push the moon away. Just as the moon, by its action on the earth, through the medium of the tides, tends to check the speed with which the earth is rotating on its axis, so the earth reacts on the moon, and compels the satellite to adopt a continuous retreat. The moon is therefore gradually receding. It is further from the earth to-day than it was yesterday, it will be farther to-morrow than it is to-day. The process is never reversed, it never even ceases. The consequence is a continuous growth in the size of the track which the moon describes around the earth. It is quite true that this growth is a slow one, so too the growth of the oak is imperceptible from day to day, though in the lapse of centuries the tree attains a magnificent stature. The enlargement of the moon's orbit, though imperceptible from month to month or even from century to century, has revolutionized our system in the lapse of many millions of years.

Looking back through the mists of time, we see the moon ever drawing nearer and nearer to the earth. Our satellite now revolves at a distance of 240,000 miles, but there was a time when that distance was no more than 200,000 miles. There was a time, millions of years ago, no doubt, when the moon was but 100,000 miles away, and as we look further and further back, we see the moon ever drawing closer and closer to the earth, until at last we discern the critical period in earth-moon history, when our globe was spinning round in a period of about five or six hours. The moon, instead of revolving where we now find it, was then actually close to the earth, earlier still it was in fact touching our globe, and the moon and the earth were revolving each around the other, like a foot ball and a tennis ball actually fastened together.

It is impossible to resist taking one step further. We know that the earth was at that early period a soft molten mass of matter, spinning round rapidly. The speed seems to have been so great that a rupture took place, a portion of the molten matter broke away from the parent globe, and the fragments coalesced into a small globe. That the moon was thus born of our earth uncounted millions of years ago is the lesson which mathematics declares it learns from the murmur of the tides.

New Telephone Transmitter.

Mr. C. F. Dunderdale, of Chicago, has recently brought out a type of telephone transmitter possessing several novel features. While recognizing the good qualities of a granular carbon in a transmitter, the tendency to packing has to be avoided, and this he has secured by means of a constant rotation of the case containing the granules, so that the carbon granules are in a constant state of reversal of position, thus preventing their settling and the ensuing separation of the grains, the finer from the coarser, the former collecting at the bottom, and the latter at the top, and which the shaking only aggravated and increased the tendency to solidify.

One of the means of accomplishing this result is to provide a lever and ratchet movement, the lever being the support hook of the receiver, the act of hanging up and taking down of which causes the rotation to be secured automatically.

Every characteristic of the voice is preserved, whether the transmitter is shouted at or whispered into, all extra-vibratory sounds or echoes being eliminated.

The St. Charles, Mo., telephone exchange is fitted up with these instruments, and users there, it is asserted, can stand off thirty feet from the transmitter and talk in an ordinary tone of voice and have their words clearly transmitted to the distant point.

IF a match is held to a celluloid billiard ball, the ball will catch fire and burn.