OUR HERITAGE OF THE MECHANICAL ARTS.—II.

BY ALEX. DEL MAR, M.E.

Among the mechanical inventions of the Solonic age were the sun-dial and sciothericon, the former to denote the hour at a given place; the latter not only to determine the altitude of the sun, but through that, the latitude of different places. Herodotus credits the sun-dial to Babylonia, while the Bible assigns it to the reign of Ahaz, eighth century. The determination of comparative latitude may have prompted the conviction of a spherical earth, which is awarded by some to Thales, and by others to Abaris, whom Harpocration assigns to the reign of Crœsus. The rudder for ships was another invention of this age. Herodotus saw it applied to sailboats on the Nile; but it was doubtless invented so soon as ships were susceptible of being built strong enough to brave the sea; and this must be assigned to some centuries previously. The same writer, in alluding to the device employed to raise the stones of the Egyptian pyramids, plainly suggests the tripod or crane, and pulley. The canal which ran through Babylon had a drawbridge, which was raised every evening, to stop the passage of pedestrians. In Samos the waters of Metelinous were brought to the city by means of an aqueduct cut through the solid rock, and lined with pipes, though of what material is not mentioned. The turning lathe is of the same (Solonic) age. In Ionia, down to the sixth century, the paper of the biblos (papyrus) was so scarce that all writings were committed to parchment. The common use of papyri cannot, therefore, be assigned in that country to an earlier age. Even down to the time of Demosthenes, a sheet of account paper cost a weight in silver equal to our quarter of a dollar. Definite weights and measures are credited to Pheidon of Argos, eighth century, though they probably came from Phœnicia, and still earlier from Babylon. Among the less important inventions chronicled by Herodotus are butter, soap, beer, refrigerators, and mosquito nets, all of which belong to the Solonic age. During the same period commerce furnished the Levantine world with amber and tin from the North, ivory from the South, spices, frankincense and cotton (byssus) from the East, and silver from the West (Spain). Many of the elements of civilization which these items suggest are to be credited to the invention of iron; for without that indispensable metal, and the reserves of copper and tin, which only iron tools could have laid open, no ship could have been built strong enough to convey them across the seas which they had to traverse from the places of their production.

The inventors of the Solonic period include Periander, Solon, Thales, Anaximander, Pisistratus, Anaximenes, Scylax, Œnopides, Pythagoras, Heraclitus, Parmenides, Aphrodisius, Diogenes of Apollonia, Harpalus, Anaxagoras, Zeno of Elea, Empedocles, Leucippus, Euclid of Megara, Plato, and Xenophon; besides a host of other illustrious names in science, statesmanship, law, and the fine arts. They begin in the seventh and end with the fifth century. In the fourth century they die out. Among the last of them is Eudoxus the astronomer and Scopas the sculptor. Between the Solonic and the Alexandrian age there is an interval of almost a century when the genius of Greece was paralyzed, probably through the deplorable results of the Peloponnesian war. Then all at once it revived, as if by magic. Alexander arose. and by his conquest of the Oriental world he stimulated and left to our inheritance those numerous arts and inventions which distinguish the civilization of Greece and Rome from all others.

The Alexandrian era begins with Demosthenes and ends with Hipparchus, when Greece fell to the arms of Rome, and its glory was permanently eclipsed. No sooner did the soldiers of Alexander distribute into the West the treasures of which they had plundered the Orient, than there arose in Asia Minor, Egypt, and the Greek states a generation of inventive talent such as the world had never yet beheld. Not only the shape, but the circumference, of the earth was determined and measured, its geography extended, its various movements traced with accuracy, and the heavens explored for that larger information upon which rest the foundations of the mechanical arts. While Pytheas explored the seas of the North, Megasthenes traversed the lands of the East, and Theophrastus searched the bowels of the earth for rare minerals. Aristarchus of Samos rose to the sublime height of asserting that heliocentric theory which Copernicus only rediscovered eighteen centuries later, and of computing the comparative dimensions of the heavenly bodies and the immense distances which separate them. It was upon these foundations of physical science that Archimedes based his treatise of mechanics, Euclid of Alexandria found assurances for his system of geometry, and Eratosthenes measured the obliquity of the ecliptic, a degree of the meridian, and, with increased precision, the circumference of the earth. The extraordinary universality of the age is typified by Aristotle, its science by Aristarchus, its mechanical genius by Archimedes, and its refinement by the sculptor of the Venus de Milo.

The inventions of the Alexandrian age were both numerous and varied. Under the Ptolemaic kings of Egypt, ships were built of lengths varying from 312 to 420 feet, the latter carrying 4,000 rowers, 400 sailors, and 2,850 soldiers, altogether more than 7,000 persons in one vessel. Demosthenes mentions a merchant ship which, besides the cargo, slaves, and crew, carried more than 300 freemen as passengers (Boackt, 69). Archimedes built a ship for Hiero of Syracuse, which was provided with dining-rooms, galleries, gardens, fish-ponds, stables, mills, baths, eight large towers, and an engine for hurling stones of 300 pounds weight and spears 36 feet long. Its decks were inlaid with scenes from the Iliad, and it contained a temple of Venus and other wonders. Although this huge vessel may have been more useful as a pleasure boat than a man-of-war, yet the Greeks of this age constructed fighting-ships of scarcely less gigantic dimensions. Not only this, but they accomplished in them the most distant voyages. That of Pytheas to the Baltic has been already mentioned. They also sent ships to the Indies, and several around the Cape of Good Hope, which, after having made the voyage from the coast of Spain, were found wrecked on the shores of Arabia. Eudoxus also made the same voyage, though in the opposite direction. However, this feat had already been performed by the Phœnicians under Pharaoh Necho, 611-605 B. C., and by the Carthaginians under Hanno. The art of sailing on a bowline, or "against the wind," if not also anticipated by the Phœnicians, belongs to the Alexandrian age. The invention of an inclosed basin or dock, for ships, is also of the same age. Philon constructed one at Athens, which harbored a thousand ships. The Maritime Code and the Colossus of Rhodes were of the same age.

(To be continued.)

THE HEAVENS IN MAY.

BY HENRY NORRIS RUSSELL, PH.D.

The evening skies are not as bright as they were a month ago. Orion and Sirius are no longer to be seen, and we have also lost the bright planets which were visible in April. In fact, the present is one of the dullest seasons of the year. The Milky Way, near which so many of the bright constellations are situated, lies low along the northern horizon, and the region which now lies highest in the sky is one where bright stars—and faint telescopic ones too—are much less numerous. Even so it does not lack objects of interest, and there are many things to be seen which are worth looking for.

Let us start our search with that landmark of the heavens, the Great Dipper, which is almost overhead at 9 o'clock on a May evening. Every one knows that the two stars at the front of the bowl are called the Pointers, because their line leads us close to the Pole-star. But this is not the only way in which we may make the Dipper useful in finding other stars. Carry the line of the Pointers in the other direction, and we pass through the southern part of Ursa Major and reach Leo, about half way between its two brightest stars, Regulus on the right and Deuebola on the left. The curving line of the Dipper handle is also a good guide. Extending the curve we come to a very bright reddish star. This is Arcturus, the brightest star in the constellation Boötes, and in the northern hemisphere of the sky. At least it is the brightest to most eyes.

It is a very difficult matter to compare the brightness of two lights of different colors, and such a comparison cannot be made anything like as accurately as in the case of two lights of the same color. Worse than this, different people, though far from color-blind, will differ in matching two such lights. For example, Prof. Young in his "General Astronomy" records that to his eye Vega is decidedly brighter than Arcturus, while most people, including the present writer, see the difference the other way. So it is really hardly possible to say which is the brighter of the two stars.

The comparison is further complicated by the fact that our own eyes are not wholly consistent in this matter. If we have two lights of different colors, say a red and a green one, and match them as well as we can, and then increase them both in brightness, say one hundred times, but in exactly the same proportion, the red light will seem to gain more in brightness than the green one, and it will now appear distinctly the brighter of the two. Conversely, if we diminish both lights equally, the green one will appear brighter than the red.

Of the different colors of the spectrum, the green has the greatest "staying power," surpassing red on the one hand and violet on the other, and also the intermediate colors, yellow and blue, in a smaller degree; so that if we had a line of lights of all these colors, apparently equally bright, and decreased them all in the same proportion, the red and violet would vanish first, then the blue and yellow, leaving the green alone. This curious peculiarity of our eyesight is known among scientists as Purkenje's phenomenon, from the name of its discoverer. It explains some familiar things, notably the almost complete absence of color in objects seen by a faint light, e. g., a landscape in weak moonlight. All ordinary objects reflect light of all colors, but colored objects reflect some colors much better than others, so that we get the impression of the color which predominates in the reflected light. But if the light is very faint, the red and violet light reflected to us will be too faint to see, while the green light, though enfeebled in the same proportion, is still visible. A red object, which reflects very little green light, will therefore appear black in a faint light and, in general, almost all color will disappear some time before the forms of objects are lost to sight.

But we are forgetting the stars. If we extend the curve through the Dipper handle and Arcturus still farther, we come upon a pretty bright white star, which is Spica in the zodiacal constellation Virgo. The other prominent stars of this group form a curving line about half way between Spica and Deuebola. Below Spica on the right is the small group of Corvus, and low on the horizon are some of the stars of Centaurus. Below these, but only fairly visible within the tropics, lies the Southern Cross.

Hydra lies along the southwestern sky, and the principal constellations in the west are Canis Minor, Gemini, and Auriga, all pretty low. Perseus is in the far northwest, and Cassiopeia lies right below the Pole. East of this comes Cepheus, and then Cygnus, not yet fully risen. Lyra is higher up, with Vega conspicuous. The "keystone" of Hercules and the semi-circle of Corona lie between this and Arcturus. Ophiucus and Serpens are in the southeast, and below them Scorpio is partly risen, but the brightest thing in this part of the sky is the planet Mars.

THE PLANETS.

Mercury is morning star in Aries. He is too near the sun to be seen at first, but later he comes into view, being at elongation on the 20th, when he rises about 3:45 A. M. and is easily visible.

Venus is also morning star, close to Mercury, and like him is best seen toward the end of the month, when she rises two hours before the sun.

Mars is in opposition on the 8th. He is in Libra, remote from any bright star, and cannot be mistaken, especially as he is brighter than anything else, even Arcturus.

It is interesting to know that on this occasion the earth comes actually between Mars and the sun, so that as seen from the planet the earth and moon transit across the sun's disk. The earth would appear as a small black dot 32 sec. in diameter—too small to be seen without a telescope—crossing the sun from east to west, a little south of the center and taking about ten hours to traverse the disk. The moon would be a much smaller dot, 8 sec. across, entering on the sun's disk some five hours after the earth and crossing it at the same rate, so that both earth and moon would be seen in front of the sun at once.

Jupiter is in conjunction with the sun on the 4th and is practically invisible this month.

Saturn is morning star in Aquarius. On the 24th he is in quadrature with the sun, rises at 1 A. M., and is due south at 6 o'clock.

Uranus is in Sagittarius, rising about 10 P. M. in the middle of the month.

Neptune is in Gemini, and sets at about 10 P. M.

THE MOON.

New moon occurs at 11 A. M. on the 4th, first quarter at 2 A. M. on the 12th, full moon at 5 P. M. on the 18th, and last quarter at 10 P. M. on the 20th. The moon is nearest us on the 16th, and farthest away on the 1st and 29th. She is in conjunction with Mercury and Venus on the 3d, Jupiter on the 4th, Mars on the 17th, Saturn on the 25th, and Venus again on the 30th. The conjunction with Saturn is quite close.

There were 66,784 cars of all classes in the United States in 1902. Of this number, 60,290 were passenger cars and 6,494 were cars used for express and other purposes. Of the passenger cars, 32,658 were closed, 24,259 were open, and 3,134 were combination closed and open cars, while 239 were combination passenger and express cars. There were 1,114 cars devoted solely to express, freight, and mail business. An interesting development in electric railway service is the construction and equipment of sleeping cars for use on long-distance lines in Ohio and Indiana. The largest number of cars of all classes for any State was reported for New York, the number being 14,049. About half of all the cars in the United States were equipped with heating apparatus, 19,021 being heated by electricity, and 11,138 by stoves, hot water, or other contrivances. Many railways, however, have two sets of cars—one for use in summer, and the other in winter—so that in winter the proportion of the cars in operation equipped with heating apparatus is larger than these statistics would at first glance indicate.