the "Twentieth Century Limited," he was impressed with the great care with which the enginemen slowed down on curves that exceeded a certain degree. During many years of observation of the action of trains on sharp curvature we have never known a fast express to run around curves at a speed exceeding the safe one, but we have many times seen such speed exceeded on slow and heavy trains that were endeavoring to make up time on down grades where the curvature was heavy.

Sixth. In the event of collision, the actual smashing effects, and therefore, the fatalities, are likely to be less in the fast than in the slow passenger train. The former will be made up of four or five cars, the latter of from eight to ten; and since the crushing in of the cars and wounding of the passengers is due to the total momentum of the train, all of which must be expended before the cars come to a state of rest, it follows that the wreckage of the ten-car train, moving at fifty miles an hour, would be far greater than that of the five-car train moving at sixty miles an hour—and this in spite of the fact that the momentum increases as the square of the velocity. In other words, it will require the crushing up of more cars to absorb the momentum of the slow heavy train than it will that of the light fast train. Had the misplaced switch been open in front of the slower nine-car "Lake-Shore Limited," for instance, the casualties would undoubtedly have been much heavier than they were in the present case.

Lastly, the fast train, like the fast transatlantic liner in a fog, is sooner through the danger space. This argument, which is accepted among steamship captains as a perfectly sound one, applies in its degree to railroad travel, for if dangers lurk on the rails, the sooner the journey is over, other things being equal (and we have shown above that "other things" rather favor the fast train than otherwise), the less the danger of injury.

We have gone somewhat fully into this question, because we believe that it affects, in the most vital way, the whole question of the increased speed of so-called express American railroad trains, which to-day, except for a few special trains, is lamentably behind that of some foreign countries. Every day of the year in France over thirty trains are run that have a schedule speed of from 55 to 60 miles an hour; and in Great Britain there are over fifty such trains. Time was when the immature state of our railroads could be urged as a plea for the low average speed of the majority of our express trains. No such plea can be urged to-day, for our best track is just as good as the best track in European countries.

THE HEAVENS IN JULY.

BY HENRY NORRIS RUSSELL, PH.D.

Two very interesting announcements have come from American observatories recently. One is from the Lowell Observatory, stating that photographs of Mars showing some of the canals have been secured there. This, if confirmed, will remove all question of the reality of these much discussed phenomena. The other is from Harvard and conveys the news that another satellite of Saturn has been discovered photographically by Prof. W. H. Pickering, raising the number to ten. It is an exceedingly faint object of about the 17th magnitude, even fainter than the ninth satellite, but in other respects it is quite unlike it or the two new satellites of Jupiter. Instead of being a distant attendant it is relatively close, having a period of about 21 days, which corresponds to a distance of about one million miles from the planet, and it revolves from west to east like the inner satellites and Saturn itself.

These values are very close to the corresponding numbers for the faintest of the old satellites, Hyperion, but Prof. Pickering's statement that Hyperion is visible on his photographs and is three magnitudes, or nearly twenty times, brighter than the new satellite disposes of all question as to their identity. It seems that here we have two satellites whose distances and periods are very nearly alike.

No such case has previously been known among satellite systems, but in the solar system the asteroids furnish an excellent analogy, for among them it is possible to pick out many pairs whose orbits are very nearly alike both in size and shape.

We may pursue the analogy further, for the new satellite is very small, probably not over 100 miles in diameter, while the largest of Saturn's satellites, Titan, has a diameter of about 3,500 miles, and the planet itself of 73,000, so that the new satellite is smaller in comparison to Titan than the latter in comparison to Saturn itself. Finally to complete the likeness, the orbits of the asteroids lie just *inside* that of Jupiter, which is much the largest of the planets, and the orbits of Hyperion and the new satellite lie just *outside* that of Titan, which is by far the largest of Saturn's satellites.

Is this remarkable similarity an accident or can we assign a reason for it? To answer this question we must enter for a moment into the realms of mathematical astronomy, where we have not to seek far for an explanation.

Every planet is attracted not only by the Sun but by all the other planets, and the closer together two of them are, the greater will be the attraction. If, therefore, two planets of considerable size had orbits which approached very near one another at any point, sooner or later they would both come near this point at the same time. Their mutual attraction would then be so great that it would alter the direction in which they moved, and after the encounter they would pursue quite different orbits from their previous ones. In certain cases the orbits might be so profoundly changed that one of the two might collide with the Sun, or be sent away into space never to return, as a result of the encounter.

Such things are liable to happen unless both the planets are very small so that their mutual attraction is insufficient to affect their motions perceptibly. We see, therefore, that the small size of the asteroids is a necessary condition for their *permanently* continuing to move in the orbits which they now possess.

But what does the neighborhood of Jupiter have to do with the existence of these small planets? Here we must go farther back into the probable history of the solar system. It is generally believed that the planets have condensed to their present forms out of much more sparsely distributed matter which perhaps once formed rings or something of that sort revolving about the Sun. Whether the parent matter of the asteroids formed a ring or not, it must have come much nearer to Jupiter than that of any of the other planets did. Now it can be shown that the attraction of Jupiter would tend to tear any such diffuse mass into separate bits. It seems therefore quite likely that the asteroids represent a planet "spoiled in the making," owing to the relative nearness of Jupiter, which prevented it from condensing into a single piece as the other planets, farther away from this disturbing influence, did.

Just the same reasoning will evidently apply in the case of the Saturnian system, where the planet takes the place of the Sun and Titan that of Jupiter. So we see that the likeness we have already mentioned is not a mere accident, but can be explained on gravitational principles.

It is tempting to extend the analogy still farther and to suggest that Hyperion and the new satellite may be only the brightest members of a group of Saturnian asteroids, but the extreme faintness of the newly-discovered object suggests that even if there are more still smaller ones they may be too faint to see or photograph.

THE HEAVENS.

Clear summer nights give us our best opportunities to became familiar with some of the brightest of the southern constellations. Scorpio, the finest of these, is on the meridian at 9 o'clock July 15, and in our latitude the whole constellation can be seen. It consists of a vertical line of three second-magnitude stars, then to the left another group of three, the central one of which is very bright and very red, and a long curving line running from these down almost to the horizon and bending back again to form the monster's tail. East of Scorpio is Sagittarius and above the two are Ophiuchus and Serpens. Above these again are Hercules and Corona. Lyra and Cygnus are farther east, near the Milky Way, and Aquila is south of them. Andromeda, Pegasus, and Capricornus are rising, but not conspicuous yet. West of the meridian the most prominent objects are Arcturus, Spica, and Mars, the latter the lowest of the three. Leo is settling in the west and Ursa Major is above and to the right of it. Draco and Ursa Minor are above the pole and Cepheus and Cassiopeia on the right.

THE PLANETS.

Mercury is evening star in Gemini, Cancer, and Leo. At first he is close to the sun and invisible but at the end of the month he can be well seen, as he sets at about 8:30 P. M.

Venus is morning star in Taurus. On the 6th she reaches her greatest elongation, being a little more than 45 deg. west of the sun. She rises about 2:30 A. M. and is the brightest thing in the morning sky. Mars is in Libra and is prominent in the evening sky, settling about midnight. Jupiter is morning star close to Venus. The closest conjunction occurs on the 4th when they are only 2½ deg. apart. Saturn is in Aquarius and rises at about 10 P. M. in the middle of the month.

Uranus is just past opposition, and is well observable. He is in Sagittarius, his position on the 15th being R. A. 18h. 6m., dec. 23 deg. 42 min. Neptune has just passed conjunction with the sun and is invisible.

THE MOON.

New moon occurs at 1 P. M. on the 2d, first quarter at 1 P. M. on the 9th, full moon at 11 A. M. on the 16th, last quarter at 8 A. M. on the 24th, and new moon once more at 11 P. M. on the 31st. The moon is nearest us on the 10th and farthest away on the 23d. She is in conjunction with Mercury on the 3d, Mars on the 11th, Saturn on the 19th, Jupiter on the 26th, and Venus on the 28th.

Cambridge University, England, June 13, 1905.

ENGINEERING NOTES.

Multiple screws were used as early as our civil war on some vessels known as "tin-clads" on the Mississippi, their adoption being necessitated by the shallow draft. Twin screws were first used in war vessels where the necessity for keeping the machinery below the deck would not allow of all the power being conveniently used on a single shaft, but the great advantage they possess of security against total disablement and for maneuvering soon made them the rule for all naval vessels large enough to admit of them. They were much longer in coming in the merchant service where the limitations on naval machinery do not obtain, but since the era of the very large transatlantic steamers beginning with the "Paris" and "New York," and the "Teutonic" and "Majestic," all very large vessels have been built with twin screws.

In the early steamers, almost the only independent steam auxiliary was a single pump which could be used for feeding the boilers while under banked fires or with the engine stopped, and for pumping the bilge. The other pumps were attached to the main engine. Such things as steam capstans and winches, steam steering gear, distilling apparatus, evaporators, forced draft blowers, and electric light engines, were not dreamed of. As time went on and the size of vessels increased, steam capstans and winches and steam steering engines came in. Then it began to be found desirable, particularly for naval engines, to remove all the pumps from the main engine, leaving it nothing to do but turn the propeller, and this brought about independent air and circulating pumps and feed pumps. Further progress introduced the distiller and evaporator, the forced-draft blowers, and the electric light engine.

Submarine boats made a brilliant performance at the recent maneuvers which the French navy carried out in the bay of Toulon. This is the first time that such maneuvers have been held in France. The idea was to combine the operations of the submarines of the port with the torpedo boats which form part of the defending fleet. The operation was as follows: A polygon had been traced in the great harbor. This polygon, which had a surface of some 3,000 square yards, was formed on one side by the shore and on the others by imaginary lines which had been determined in advance. A squadron composed of six torpedo boats of the fleet, headed by the destroyer "La Dragonne," was detailed to defend and keep a lookout upon the polygon. On the other hand, five submarines were to traverse the space from one end to the other, without being seen or localized by the torpedo boats. The maneuver took place during the forenoon. It proved to be of a most instructive character, and gave some very conclusive results as to the operation of the submarines. The torpedo boats, which had an entire freedom of movement, ranged themselves at the extremity of the polygon, and facing the shore, on a line parallel to the latter, so as to have a wide field of vision before them. The sea was remarkably calm and exceptionally transparent at that time, which gave the least favorable conditions for the submarines. Besides, these small craft are the oldest of the series and the first to be built, so that they had not the benefit of the great improvements which have been recently made. The "Zédé," the "Gymnote," and three other submarines of the same type were ranged in line. In spite of the clearness of the water, the freedom of movement of the torpedo boats, and the sharp lookout which the officers and crew kept up in order to note the smallest disturbance at the surface, the five submarines were able to traverse the whole width of the polygon and were quite invisible, and no one was able to reveal their presence or to say at what time they had passed across the space. Only one of the torpedo boats, the No. 140, in the report which it presented to the commandant of the defense, stated that during a few seconds a slight bubbling was noted, this no doubt being caused at the surface of the sea by a periscope which came near the top, but the duration of the disturbance was so short that no exercise of sighting could be made, and in spite of the efforts which were made at once, it was quite impossible to discover the path of any of the submarines. The naval authorities here consider that this experiment which is tried for the first time with the torpedo boats and submarines, is among the most important and conclusive, and justifies the confidence which the navy has in the good performance of the submarines.

The railway companies in Switzerland have determined that for the future all children under 2 feet 1 inch in height will be passed at half fare, and those above, whatever their ages may be, will be treated exactly as adults. At each station, near the booking-office, a measuring machine is to be fixed, and whenever a child applies for a half-fare ticket it will be invited to stand under the scale.