TURTLES IN THE ZOOLOGICAL GARDEN AT HAMBURG.

When the keeper goes early in the morning to the large new turtle cage of the reptile gallery of the Zoological Garden at Hamburg with a basket filled with green vegetables, when he fills the long crib, which, with its crossbars, resembles a cattle rack, then there is life and movement among the amphibians. Some remain quiet even then, with their heads drawn in, perhaps enjoying a sweet morning nap, and others crawl slowly along, paying little attention to their surroundings. One would scarcely imagine that these creatures would so quickly notice the presence of the keeper with the food. One after another hastens to the rack, but a few, like the immense sea turtle, with the fin-like front legs, turn in disgust from the plant food, and the long-tailed alligator turtle, a real beast of prey, simply watches the others at their food. It need scarcely be explained that later meat and fish will be provided for them.

There are now 102 turtles in the Hamburg Garden, which represent 32 different species.—Illustrirte Zeitung.

The Size of the Solar System.

BY J. E. GORE, F.R.A.S.

As my readers are aware, the solar system consists of a number of planets revolving round the sun as a center, and of subordinate systems of satellites revolving round the planets, or at least round some of them. Our own earth is one of these planets, the third in order of distance from the central luminary, which forms the common source of light and heat to all the members of the system. In addition to the planets and satellites, there are also some comets which form permanent members of the solar system. Some of these comets revolve round the sun in very elongated orbits, while the planets revolve in nearly circular orbits. A consideration of the absolute size of this planetary system and its relative size compared with that of the universe of stars, or at least the universe visible to us, may prove of interest to the general reader.

To determine the size of the solar system, it is, of course, necessary, in the first place, to ascertain the dimensions of the planetary orbits with reference to some standard, or unit of measurement, as it is termed. The unit of measurement adopted by astronomers is the sun's distance from the earth. As the earth is the third planet in order of distance from the sun, this distance is, of course, an arbitrary unit. We might take the mean distance of Mercury from the sun as the unit, but as we refer all our measurements to terrestrial standards, and the diameter of the earth is used in the measurement of the sun's distance, it is found more convenient to take the sun's distance from the earth as the standard of measurement for the solar system and the distance of the stars.

The relative distances of the planets from the sun have been determined by astronomical observations, and are represented approximately by the following figures, the earth's mean distance from the sun being taken as unity: Mercury, 0·387; Venus, 0·723; the earth, 1·0; Mars, 1·523; the minor planets, 2·08 to 4·262; Jupiter, 5·203; Saturn, 9·538; Uranus, 19·183; and Neptune, 30·055; or, taking the earth's mean distance from the sun as 1,000, the distance of Mercury will be represented by 387; Venus, 723; Mars, 1,523; the minor planets, 2,080 to 4,262; Jupiter, 5,203; Saturn, 9,538; Uranus, 19,183; and Neptune, 30,055. These are the mean or average distances, the orbits not being exact circles but ellipses of various eccentricities, that of Mercury—among the large planets—being the most eccentric and that of Venus the least so. Among the minor planets the eccentricities vary from 0; or a perfect circle, to 0·44, the value found for a small planet discovered by M. Wolf in November, 1894.

The first scientific attempt to determine the sun's distance from the earth seems to have been made by Aristarchus, of Samos. His method was to note the exact time when the moon is exactly half full, and then to measure the apparent angle between the centers of the sun and moon. It is evident that when the moon is half full the earth and sun, as seen from the moon, must form a right angle with each other, and if we could then measure the angle between the sun and moon, as seen from the earth, all the angles of the right-angled triangle formed by the sun, moon and earth would be known, and we could deduce at once the relative distances of the sun and moon from the earth. This method is, of course, perfectly correct in theory, but in practice it would be impossible, even with a telescope, to determine the moment when the moon is exactly half full, owing to the irregularities of its surface. Aristarchus had no accurate instruments, and no knowledge of modern trigonometry, but by means of a tedious geometrical method he concluded that the sun is nineteen times further from the earth than the moon. This result we now know to be far too small, the sun's distance from the earth being in reality about three hundred and eighty-eight times the moon's distance.

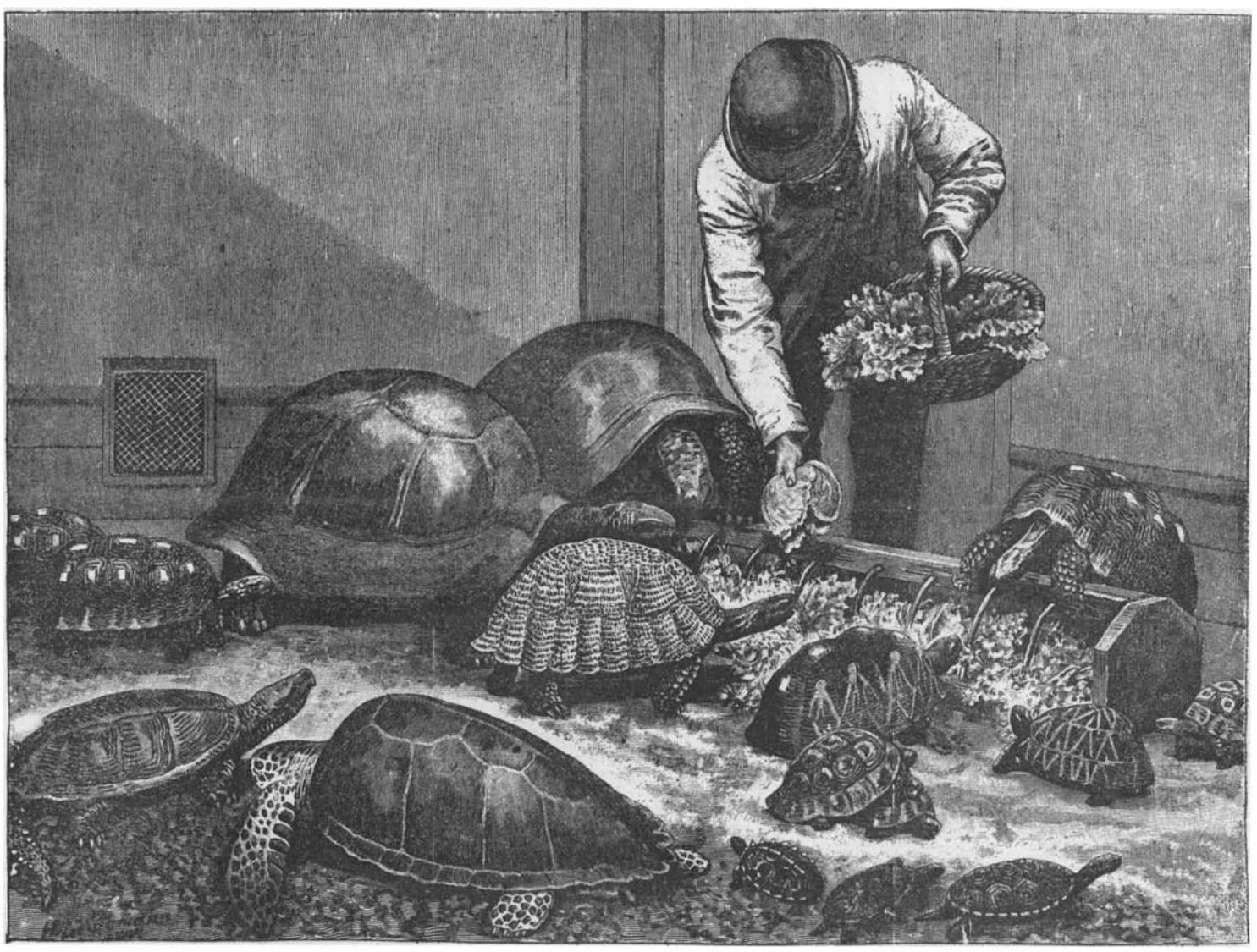
In modern times the sun's distance has been determined by various methods. The most recent results tend to show that the sun's parallax, as it is termed, cannot differ much from 8·81 seconds of arc. The solar parallax is the angle subtended at the sun by the earth's semi-diameter. A parallax of 8·81 seconds implies that the earth's mean distance from the sun is about 92,790,000 miles. Multiplying this number by the figures given above, we find that the mean distances of the planets from the sun are as follows, in round numbers: Mercury, 35,909,000 miles; Venus, 67,087,000; Mars, 141,384,000; the minor planets, 193,000,000 to 395,470,000 miles; Jupiter, 482,786,000; Saturn, 885,105,000; Uranus, 1,779,990,000; and Neptune, 2,788,800,000. This makes the diameter of the solar system, so far as at present known, about 5,578 millions of miles. Across this vast space light, traveling at the rate of 186,300 miles per second would take eight hours nineteen minutes to pass.

But vast as this diameter really is, compared with the size of our earth, or even with the distance of the moon, it is very small indeed when compared with the distance of even the nearest fixed star, from which light takes over four years to reach us. The most reliable measures of the distance of Alpha Centauri, the nearest of the fixed stars, places it at 275,000 times the sun's distance from the earth, or about 9,150 times the distance of Neptune from the sun. If we represent the diameter of Neptune's orbit by a circle of two inches in diameter, Alpha Centauri would lie at a distance of 762 feet, or 254 yards, from the center of the small circle. If we make the circle representing Neptune's orbit two feet in diameter, then Alpha Centauri would be distant from the center of this circle 9,150 feet, or about 1¾ miles.

As the volumes of spheres vary as the cubes of their diameters, we have the volume of the sphere which extends to Alpha Centauri 766,000 million times the volume of the sphere containing the whole solar system to the orbit of Neptune. If we represent the sphere containing the solar system by a grain of shot one-twentieth of an inch in diameter, the sphere which extends to Alpha Centauri would be represented by a globe 38 feet in diameter.

It will thus be seen what a relatively small portion of space the solar system occupies compared with the sphere which extends to even the nearest fixed star. But this latter sphere, vast as this is, is again relatively small compared with the size of the sphere which contains the great majority of the visible stars. Alpha Centauri is an exceptionally near star. Most of the stars are at least ten times as far away, and probably many a hundred times further off. A sphere with a radius 100 times greater than the distance of Alpha Centauri would have a million times the volume, and therefore 766,000 billion times the volume of the sphere which contains the whole solar system!

From these facts it will be seen that enormously large as the solar system absolutely is, compared with the size of our own earth, it is, compared with the size of the visible universe, merely as a drop in the ocean.—Knowledge.



TURTLES IN THE ZOOLOGICAL GARDEN AT HAMBURG.

THE largest landed estate is that of the Czar Nicholas of Russia, 100,000,000 acres.

How Goodyear Became a Rubber Inventor.

The ruinous failure of the earliest American rubber manufacturers, says a writer in the Boston Commercial Bulletin, arose from the fact that they began their costly operations in ignorance of the qualities of the material which they had to deal with. No one had discovered any process by which India rubber once dissolved could be restored to its original constituency, and the importance of this item was overlooked until many men had been ruined.

It was in the year 1820, the same writer continues, that a pair of India rubber shoes was seen for the first time in the United States. They were covered with gilding, and resembled in shape the shoes of a Chinaman. They were handed about in Boston only as a curiosity. Two or three years after, a ship from South America brought to Boston 500 pairs of shoes, thick, heavy, and ill-shaped, which sold so readily as to invite further importations. The business increased until the annual importation reached half a million pairs, and India rubber shoes had become an article of general use.

The manner in which these shoes were made by the natives of South America was frequently described in the newspapers, and seemed to present no difficulty. They were made much as farmers' wives made candles. The sap being collected from the trees, clay lasts were dipped into the liquid twenty or thirty times, each layer being smoked a little. The shoes were then hung up to harden for a few days; after which the clay was removed, and the shoes were stored for some months to harden them still more.

Nothing was more natural than to suppose that Yankees could do this as well as Indians, if not far better. The raw India rubber could then be bought in Boston for five cents a pound, and a pair of shoes made of it brought from $3 to $5. Surely here was a promising basis for a new branch of manufacture in New England. It happened, too, in 1830, that vast quantities of the raw gum reached the United States. It came covered with hides, in masses, of which no use could be made in America; and it remained unsold, or was sent to Europe.

Patent leather suggested the first American attempt to turn India rubber to account. Mr. E. M. Chaffee, foreman of a Boston patent leather factory, conceived the idea, in 1830, of spreading India rubber upon cloth, hoping to produce an article which should possess the good qualities of patent leather, with the additional one of being waterproof. In the deepest secrecy he experimented for several months. By dissolving a pound of India rubber in three quarts of spirits of turpentine, and adding lampblack enough to give it the desired color, he produced a composition which he supposed would perfectly answer the purpose.

He invented a machine for spreading it, and made some specimens of cloth, which had every appearance of being a very useful article. The surface, after being dried in the sun, was firm and smooth; and Mr. Chaffee supposed, and his friends agreed with him, that he had made an invention of the utmost value. At this point he invited a few solid men of Roxbury, Mass., to look at his specimens and listen to his statements. He convinced them. The result of the conference was the Roxbury India Rubber Company, incorporated in February, 1833, with a capital of $30,000.

The progress of this company was amazing. Within a year its capital was increased to $240,000. Before another year had expired, this was increased to $300,000; and in the year following, to $400,000. The company manufactured the cloth invented by Mr. Chaffee, and many articles made of that cloth, such as coats, caps, wagon curtains and coverings. Shoes made without fiber were soon introduced. Nothing could be better than the appearance of these articles when they were new. They were in the highest favor, and were sold more rapidly than the company could manufacture them.

The astonishing prosperity of the Roxbury company had its natural effect in calling into existence similar establishments in other towns. Manufactories were started at Boston, Framingham, Salem, Lynn, Chelsea, Troy, and Staten Island with capitals ranging from $100,000 to $500,000; and all of them appeared to prosper. There was an India rubber mania in those years similar to that of petroleum in 1864. Not to invest in India rubber stock was regarded by some shrewd men as indicative of inferior business talents and general dullness of comprehension.

The exterior facts were certainly well calculated to lure even the most wary. Here was material worth only a few cents a pound, out of which shoes were quickly made, which brought $2 a pair! It was a plain case. Besides, there were the India rubber companies, all working to their extreme capacity, and selling all they could make. Such were the conditions of the trade when Charles Goodyear visited the New York office of the Roxbury Rubber Company to suggest some improvements in inflating a life preserver manufactured by the company. To his surprise the agent took him into his confidence and explained that the prosperity of all the India rubber companies in the United States was only apparent; that they needed an ingenious inventor to save them all from ruin.

The Roxbury company had manufactured vast quantities of shoes and fabrics in the cool months of 1833 and 1834, which had readily been sold at high prices; but, during the following summer, the greater part of them had melted. Twenty thousand dollars' worth had been returned, reduced to the consistency of common gum, and emitting an odor so offensive that they had been obliged to bury it. New ingredients had been employed, new machinery applied, but still the articles would dissolve. In some cases, shoes had borne the heat of one summer and melted the next. The wagon covers became sticky in the sun and rigid in the cold.

The directors were at their wits' end; since it required two years to test a new process, and meanwhile they knew not whether the articles made by it were valuable or worthless. If they stopped manufacturing, that was certain ruin. If they went on, they might find the product of a whole winter dissolving on their hands. The capital of the company was already so far exhausted that, unless the true method were speedily discovered, it would be compelled to wind up its affairs.

The agent urged Mr. Goodyear not to waste time upon minor improvements, but to direct all his efforts to finding out the secret of successfully working the material itself. The company could not buy his improved inflator; but let them learn how to make an India rubber shoe that would stand the summer's heat, and there was scarcely any price which it would not gladly give for the secret.

The worst apprehensions of the directors of this company were realized. The public soon became tired of buying India rubber shoes that could only be saved during the summer by putting them into a refrigerator. In the third year of the mania, India rubber stock began to decline, and Roxbury itself finally fell to $2.50. Before the close of 1836, all the companies had ceased to exist, their fall involving many hundreds of families in heavy loss. The clumsy, shapeless shoes from South America were the only ones which the people would buy. It was generally supposed that the secret of their resisting heat was that they were smoked with the leaves of a certain tree, peculiar to South America, and that nothing else in nature would answer the purpose.

The $2,000,000 lost by these companies had one result which has proved to be worth many times that sum: it led Charles Goodyear to undertake the investigation of India rubber. That chance conversation with the agent of the Roxbury company fixed his destiny.

RECENTLY PATENTED INVENTIONS.

Engineering.

WATER TUBE BOILER.—Frank Printz, New Orleans, La. This is an improvement in boilers having a steam drum supported on water legs which connect it with mud drums, and provides a duplicate construction and combination of pipe coils with valve attachments whereby a portion of the apparatus may be isolated, while its duplicate is left intact, to facilitate repairs, etc. The main portion of the generator proper is inclosed by a metal casing having a hinged top and sides to facilitate access thereto, and is preferably lined with asbestos and fire tile up to the height of the fire box.

Railway Appliances.

CAR COUPLING.—Andrew J. Clark, Madison Station, Miss. Upon the front of a coupling head at the forward end of a spring-pressed draw bar are hooks projecting from the top and bottom sides of draught hook bodies, there being a tripping dog above the coupling head block, and flexible connections between the hooks and tripping dog, and means for operating the connections from a car, the locomotive, or the ground. With this improvement the cars are coupled automatically as they come together, the coupling working equally well on a straight track or on curves, and whether the car tracks are of the same or different heights.

AIR BRAKE.—John M. Hurst, Salt Lake City, Utah. This invention provides for retaining the air in the brake cylinders while recharging the auxiliary reservoirs, and consists of a pressure-retaining valve, a pressure-retaining reservoir, a valve interposed between the triple valve and the retaining valve, and a retaining pipe connecting the train pipe with the interposed valve. Each car exhausts its own air, and the amount is shown by the gage on the engine, while the pressure in all the brake cylinders of the train is equalized and the air now lost in applying the brakes is saved.

CAR FENDER.—Alexander S. Williams, Long Island City, N. Y. This fender consists of rods or bars hinged together to form a lazy tongs structure adapted to be collapsed or distended, rollers adapted to travel on the rails being located on the lower portion of the fender. These fenders are designed to be placed at each end of a car, and when the car is placed in a shed the fenders fold up in small compartments beneath the dashboard.

SWITCH MECHANISM.—Sumter B. Battey, New York City. This is an improvement on a formerly patented invention of the same inventor, and provides a mechanism more especially designed for use on street railroads, and enabling the operator in charge of the car to readily set the switch according to the direction in which the car should travel.

Electrical.

ELECTRIC MOTOR.—Addison E. Boggs, Allegheny, and Fremont J. Cleaver, Beltzhoover, Pa. This is a motor especially adapted for direct connection with the machine to be driven or with line shafts or car axles, or for use in connection with gearing or pulleys and belts, for diminishing or increasing the speed. A field magnet is secured to one side of a wheel and an armature is mounted on the axle, while a commutator wheel is mounted on the boss of the armature and has an insulated rim upon which are placed commutator bars, an insulated ring being secured to the pole pieces of the field magnet. Inwardly extending studs secured to the insulated ring carry brushes, and metallic rings secured to the face of the insulated ring are connected with the studs.

TROLLEY AND TROLLEY POLE.—Wilbur L. Pepper, Philadelphia, Pa. According to this improvement a vertical pole is employed which permits the car to run with equal facility in both directions, an automatic device permitting the pole to yield vertically, according to the varying distance between the wire and car. The trolley wheel is held with an even pressure against the wire, making good contact during all the oscillations of the car and changes in the wire, while the good connections prevent excessive sparking.

Mechanical.

BAND AND SCROLL SAW ATTACHMENT.—Herman D. Hinternesch, Baltimore, Md. This attachment comprises a transversely tilting or rocking table with longitudinally movable guide devices to tilt the table in opposite directions, there being also back rests for the rear end of the timber being sawed, and the back rest and table having recessed and interlapping portions permitting the timber to be moved past the saw. The attachment may be conveniently applied to an ordinary band or scroll saw, to facilitate sawing hand rails, mouldings, etc., for circular or curved stairways, the apparatus being conveniently adjustable to saw to any given circle or curve, and any degree of pitch or rise.

COTTON GIN.—John B. Crowder, Talucah, Ala. This inventor has devised an attachment to an ordinary gin for removing dust, dirt, chaff or other trash from cotton as it comes from the saw and for breaking up bunches, curls or condensed portions of the cotton. It consists of a narrow ribbed or flanged concave beneath the gin brush, with open places adjacent to the ribs to permit a downward air draught.

WATER MOTOR.—Mifflin W. Baily, Pottstown, Pa. According to this invention, the outlet valve of a flume discharges the water into a vessel held on the upper end of an inclined hollow working lever forming a connection between the upper vessel and a second vessel on the lower end of the lever, both vessels having valves having connections with fixed points and adapted to open and close alternately. The motor is designed to utilize the water to the fullest advantage without any waste.

Miscellaneous.

BICYCLE COAT.—Ansel B. Falk, New York City. This invention provides a brace for the inside of the back of the coat, designed to prevent the wearer from stooping forward as much as bicycle riders often do, the brace being virtually an integral portion of the coat. It consists of a centrally located pad of elastic material with divergmg straps emanating from the ends and top of the pad and attached to the garment at the side back portions and at the collar portion.

PRESCRIPTION FILE.—Albert M. Stanley, Springfield, Col. This improvement comprises a casing in which are reels to receive the filing tapes, a table being located adjacent to an opening in the casing and rollers journaled at the ends of the table, while a tape secured to the reels passes over the rollers and table. Any prescription filed may be brought to view and as conveniently read as though it were not upon file, and files stored away may be as conveniently read as those in the file casing.

WHEEL.—Chilion T. Pelton, Riverside, Cal. This wheel is more especially designed for reapers and mowers, preventing dust and sand from being carried upward to enter the journal boxes or clog up parts of the machine. It has a flat rim with flanges on each side, cover plates on each side of the rim having latches engaging the flanges, the latches having handles outside the cover plates. These cover plates may be fitted to any form of wheel.

THILL SUPPORT.—Charles A. Rotthouse, Brandywine Hundred, Del. This device consists of a spring rod bent at its middle to form loops receiving bolts for attaching it to the under side of a thill, the remaining portions of the rod being bent to form two spring coils and bearing portions engaging a bolt of the clip on the axle. The device is designed to securely hold the shaft in raised position, while yielding when the shaft is to be swung down.

HEEL PLATE.—Percy J. Van Valkenburg, New York City. On the under side of the shoe, according to this improvement, are two eyelets, one with a closed and the other with an open eye, the eyelets having split shanks which are passed through the heel and clinched on the inner side, in connection with which is used a plate having two ears, each capable of completely removable connection with the eyelets. The plate may be applied where the wear is greatest, and may be readily reversed as it is worn down on one side.

GATE.—Franklin R. Winters, Tulsa, Indian Territory. This is primarily a farm gate, of the lifting and swinging variety, and may be conveniently opened and closed by one on foot or in a vehicle. A rock shaft has a double crank hinged to the gate, and a duplex rock arm on the shaft has a locking limb projected between the duplex limbs, while a bracket plate with triple notched flange is adapted to receive the locking limb in either of the notches of its flange. The working parts are strong, inexpensive, and not liable to derangement or need of frequent repair.

GATE.—James Simpson, Veedersburg, Ind. This is a gate which may be opened or closed from either side by drawing down on a latch cable or on a lever cable, and it may be opened toward or away from the person operating it. A rearwardly extending lever fulcrumed on the swing post has a sliding connection with the gate, there being a cable connected with the rear end of the lever, and a second cable also so connected but having a bearing at the opposite side of the lever, the cables thus exerting force in opposite directions on the lever.

INTERMITTENT ROTARY MOTION.—Georg F. Haldkjar, Copenhagen, Denmark. A mechanism for producing intermittent abrupt movements or "jerks," such as may afford an effective display of figures for advertising purposes, etc., has been devised by this inventor. It comprises an arm mounted to swing and provided with projections, while a disk is mounted to rotate about an axis eccentric to the swinging arm, the disk having alternating notches and solid portions moving across the path of travel of the projections of the arm.

COW MILKING MACHINES.—Jerry E. Harvey and Joseph H. Hoover, Hubbard, Iowa. These inventors have devised an apparatus for maintaining and regulating vacuums in these machines, by which a practically uniform expansion and tension of the air may be maintained in the milk receiver and its connections during the entire milking operation, irrespective of the quantity of milk drawn into the receiver. The apparatus comprises means for automatically expanding the air exhaust chamber as the air tension varies with the inflow of milk, there being a tubular connection between the chamber and the receiver or teat cups.

WARDROBE.—Robert H. Rodgers, Nashua, N. H. This is a construction especially adapted to be stored under a bed in houses deficient in closet room, and has a shallow, box-like body, with rollers on the bottom and handles at the front, while a cover slides on its top, cleats in the under side of the cover fitting in grooves in the inner sides of the body.

PROTECTIVE PAPER FOR CHECKS, ETC.—Herman Remke, Newport, Ky. This invention provides for treating the paper after it has been written upon with certain solutions to change its ink-receiving qualities. Two solutions are successively applied, the first being composed of three parts of some essential oil, preferably oil of lavender, sixteen parts of tincture of saffron and twenty-one parts of alcohol, and the second being a concentrated alkaline solution, preferably sodium carbonate in water. The quality of the paper is thus permanently changed, so that it will not readily take ink and the writing is not destroyed or blurred. The solutions are applied with a felt pad or stamp.

STRETCHER AND AMMUNITION CARRIER.—Frederic Remington, New Rochelle, N. Y. A wheel is loosely mounted upon an axle, according to this improvement, and telescopic cushioned arms are pivoted on the axle at opposite sides of the wheel, each arm hav-