Such a prospect naturally leads us to consider the relations of the navy to science. Scientific organizations have shown on every occasion their high appreciation of the efforts of naval officers to secure a scientific training for themselves, and to advance knowledge by their own efforts. Every thing they have done has met with generous recognition from their civilian co-laborers, and they are received upon terms of perfect equality in every enterprise in which they have taken part. There is no scientific position which would be denied them on the ground that they were naval officers, and therefore to be regarded as inferiors. To maintain this cordial relationship, nothing more is necessary than that the officers should admit the equality, and make no claims except those which are founded upon merit. When they begin to claim precedence and control on the ground of naval rank, they assume a position in which they will meet with the combined opposition of their scientific co-laborers, and render all co-operation impossible.

The application of these considerations to the present case is very simple. Naval officers will not find, in scientific quarters, the slightest opposition to their doing any work at the observatory which will either advance science, or lead to their own professional improvement. It is, indeed, a mooted question, whether the work can really be well performed by any but a permanent staff of trained assistants, and it must be admitted that the observations made by naval officers in the early years of the establishment were not a success. But the officers may justly claim that what they did then is no test of what they can do now, when a better training has been secured, and a scientific spirit has been infused into the service. There is no such question raised on the scientific side as, Shall you or shall we do the work? Shall you or shall we superintend it? What is, then, the ground taken by the general scientific sentiment of the country? Of course, in answering a question of this kind, differences of individual views will be found, and no answer can be given which all will accept without modification. But we are persuaded that there will be no difficulty in reaching some conclusions which will correctly represent the average common sense of the great mass of those who are interested in the subject. We state them as follows: —

Give the naval officers every possible chance, and let them do every thing which they shall prove themselves able to do. Let the superintendent be the man, who, in the opinion of the astronomers of the country, is best fitted for the place, whether naval officer or civilian.

But let the questions, what shall the observatory do, how shall it be done, and is what is done good, be decided exclusively by the highest scientific authority, acting, not privately, and upon the motion of the superintendent, but officially, with the weight and responsibility of legal appointment. Let this authority represent, not merely the navy department or naval science, but the science of the whole country, and let the superintendent, whoever he may be, be responsible for executing its decisions. The shape it would naturally take would be that of a board of control, composed of the leading astronomers of the country.

We state these points, not as forming a definite plan, or even laying a basis for such a plan, but only as indicating the spirit in which we hold that the case should be considered by the two parties. What we ask is as much for the intellectual benefit of the navy itself as for the good of science, and we earnestly hope that naval officers will meet our views in the spirit in which they are put forth.

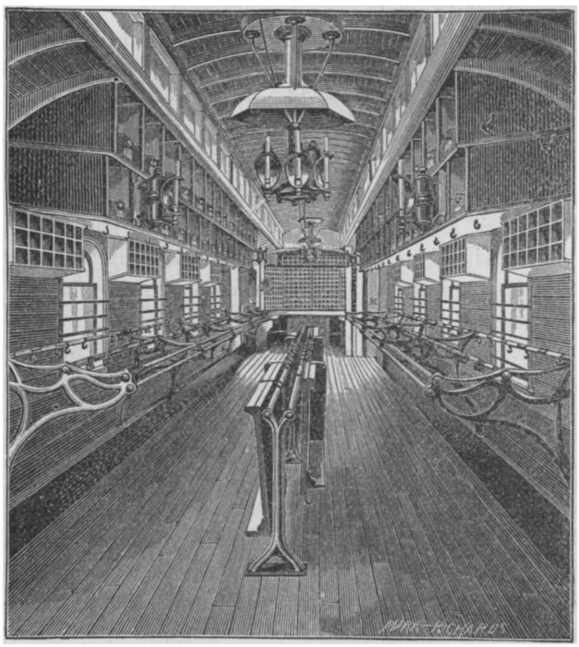
THE NATIONAL RAILWAY EXPOSITION.[1] — V.

THE postal-car shown by the Harrison postal-bag rack company of Fond du Lac, Wis., appears to be conveniently arranged, and possesses many ingenious but simple devices for facilitating the conveyance and sorting of letters and newspapers. The sorting-tables are not fixed, but are hinged by means of hooks on movable stanchions; and each table, measuring about forty-two inches by eighteen inches, can be detached and stowed away, so that any num-

[1] Concluded from No. 26.

ber can be utilized, and the remaining space left clear. The mail matter can also be sorted directly into bags, which are hung open mouthed, at their four corners, on cast-iron brackets, and these can also be folded out of the way when not required. The letter-boxes are provided with clips, into which labels can be inserted, showing the destination of the letters sorted into each particular box.

The Pullman palace-car company had a very large exhibit of sleeping and dining cars, including an emigrant sleeping-car, which will doubtless prove a great luxury to settlers journeying to the far west. The berths are arranged as in an ordinary sleeping-car, but consist merely of slats of ash, the bedding and mattress (if any) being provided by the emigrants themselves.



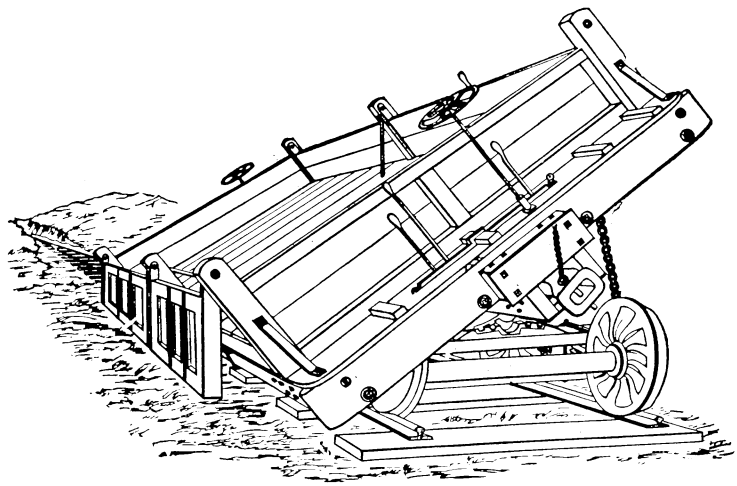
POSTAL-CAR RACKS.

A new style of sleeping-car, the second of its kind ever built, was shown by the Paige sleeping-car company. The top berth does not fold up against the roof of the car, but is a species of rectangular hammock, hung at the ends from partitions between the sections. These partitions, in the day-time, are lowered into a space between the backs of the seats. The lower berth is not made on the seat, but on a similar canvas hammock.

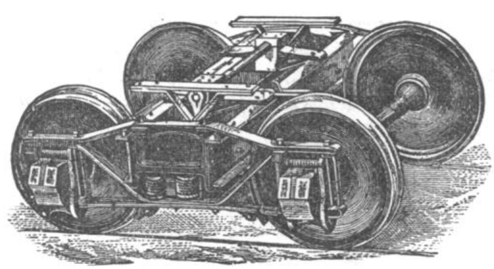
A screw lever dump-car on Van Wormer's patent is shown by the U. S. car company of Boston, Mass. The centre support on the trucks is a species of ball-and-socket joint, combined with segments of two-toothed wheels, — one segment being bolted to the top of the truck-bolster, and the other to the under side of the bottom framing of the car; the effect being, that, when the car is tipped, it rolls on the trucks, the fulcrum on which it rolls being brought directly under the centre of gravity of the car and its load, which, of course, shifts as the car is tipped. When the load is dumped, the position of the centre of gravity tends to restore the car to its normal position: the arrangement, therefore, assists the man in charge both in dumping, and in restoring the car to its running position. The rockers, with the central ball and socket and segmental cogs or teeth on either side, are shown in our illustration. When the car is to be dumped, the side-supports are withdrawn by means of levers on the end-platforms, and the car is tipped to either side by means of a worm actuated by a hand-wheel. As the bottom of the car is solid, it can be made stronger than a hopper-bottom car, and can be used for freight, which requires a flat floor, and cannot be loaded in a hopper-bottom car. It is stated that one man can unload forty thousand pounds of coal, sand, ballast, or iron ore, in two minutes by means of a dump-car, two hours being required to shovel out the same load.

The Suspension car-truck manufacturing company of New York exhibited several trucks made on their principle, suited for freight, passenger, and horse cars, and showed a model truck which traversed an abnormally rough piece of track with a very smooth and easy motion. The car is connected to the truck by means of links, which swing in a vertical plane parallel with the track, instead of at right angles to it, as in the swing-beam truck; while the axle-boxes are connected to the trucks by means of links, which permit independent side-motion to each axle. The normal position of all the links is vertical, and they become inclined as the truck enters a curve, and therefore tend to restore it to a central position when the truck enters a piece of straight track again.

The principle of the truck is entirely novel, and, though really simple, is best understood by a few minutes' examination of a model. Two brackets, resembling the letter A reversed, are attached to the under side of the car. At the apex (now the lowest point) of the A are attached vertical links, the other end of which are attached to the truck at *B*, *B*, in our diagram. As the truck enters a curve, one of these links becomes inclined forward, and the other backward. As the wheel *C* strikes against the outer rail of the curve, it is thrown towards the inside of the curve (assuming the position shown by the dotted lines in the figure), and the suspension-links force that side of the truck forward, while the wheel *D* comes backwards; and therefore the action of the links tends to make the axles radiate to the curve. No centre-pin is used; and therefore, when a car is heavily bumped in switching, it merely swings backward on the links until they become sufficiently inclined to drag the truck after the car. It should be noted that the pin *E*, which connects the links to the truck, is a loose fit in the links, and therefore allows of the necessary radial motion. The top ends of the links, being attached to the truck, are always approximately a fixed distance above the rails; and therefore, when they are inclined, the car itself is lifted, and the weight of the car, hence, tends con-



DUMP-CAR.



SUSPENSION CAR-TRUCK.

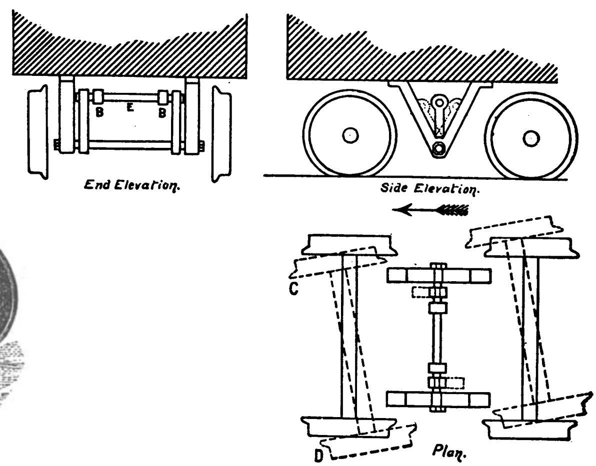
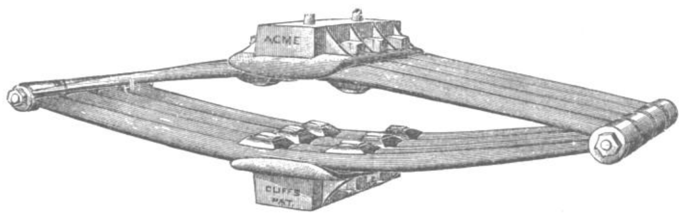


DIAGRAM SHOWING ACTION OF SUSPENSION CAR-TRUCK.

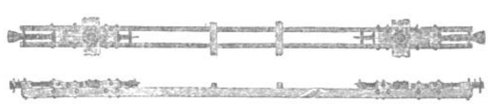
stantly to keep the links vertical, and maintain the truck in its normal position, with the axles at right angles to the axis of the car, so that it runs steadily on a straight line. The truck appears to be very highly thought of by the master car-builders, whose convention was held in Chicago during the exposition; and it is possible that it may come into extended use, the experience of the Boston and Albany, Connecticut River, and other roads which have used it, being strongly in its favor.

The Cliff and Righter company of Oswego, N.Y., exhibited a car-spring which gives an equal amount of elasticity, with a less amount of metal than the ordinary elliptic spring. Each half-spring consists of a solid steel bar of oval section, properly tapered towards the ends. Springs as usually made, of four, five, or more plates, resemble a set of somewhat elastic girders, the depth of each of which is the thickness of the plate; and the strength of a spring is the sum of the strength of each individual plate or girder, modified by the friction between the plates. It is obvious, that, were the plates to firmly adhere together, the strength of the spring would either be very largely increased, or the same strength might be attained by the use of a less number of plates; and the latter course has been carried to its limit by the patentee of the Cliff spring. A spring made of one plate must be of good steel, as, when loaded, the difference in the alteration of the lengths of its upper and lower surfaces is considerable, demanding a highly elastic steel. In the spring we illustrate, four springs are arranged side by side, — a plan which unites the advantages of a plate spring and a solid spring. Should one spring break, the other three will probably carry the load, while four springs side by side weigh no more than a spring of the same total strength, composed of a single bar of the same thickness, but of four times the width. A set of these springs for a passenger-car weighs nine hundred and twenty-eight pounds, while a set of the Pennsylvania railroad standard springs for the same purpose weighs sixteen hundred and thirty-two pounds, a difference of seven hundred and four pounds in favor of the solid spring. These springs have been lately introduced, and are being tried on the Boston and Albany and other railways. The difficulties of tempering and making a spring of one solid bar are considerable; but it is to be hoped they may be surmounted, as the weight of cars is a serious evil, "which has increased, is increasing, and ought to be diminished."



ELLIPTIC CAR-SPRING.

Mr. S. P. Tallman of New York exhibits a safety-drawbar for cars. Two pieces of timber are bolted between the middle sills of a car, and others are bolted to the under side of these timbers and the middle sills, forming a solid mass of timber, which receives both the buffing and drawing strains, the drawbar running through the timber, and being provided with springs at both ends. The spring nearest the draw-head takes the buffing-strain, and the spring at the end of the drawbar serves as a draw-spring. The disposition of the timbers enables them to be secured by more than the usual number of bolts, and the arrangement appears to be strong and simple, and not so liable to failure as the ordinary draught timber.


DRAWBAR.

Numerous refrigerator-cars were exhibited; and doubtless improvements will be much facilitated by the opportunities thus given to secure information, though it is to be regretted that the management of the exposition did not take steps to secure an efficient competitive trial of the cars under practical conditions. Beer, fruit, vegetables, etc., might have been placed in the cars, and locked up for a few days, when a careful examination of the contents would have given some indication of the relative merits of the cars.

The use of continuous brakes on passenger-trains has been found to be so advantageous, that their adoption on freight-trains is merely a question of time. Several forms of continuous brakes, applicable to freight-trains, were exhibited; the Westinghouse brake company showing a cheaper form of their well-known automatic brake, the reservoir being made of cast iron, and bolted to the cylinder. The triple valve, however, and other parts, differ little, except in size, from the brake used on passenger equipment. A cheaper form of brake, which requires no special pump or other fittings on the engine, or even a continuous brake connection through the train, is operated by the action of the ordinary hand-brake on the tender. The consequent compression of the draw-heads in the train is made by the peculiar mechanism of this brake-gear to apply the brake-shoes to the wheels of the cars.

This form of brake is peculiarly applicable to freight-service, as it allows of cars not fitted with the brake being run in the train without interfering with the use of the brake on the cars equipped. This class of brake can hardly be termed 'automatic' in the fullest sense of the term, insomuch as it does not work, should the train part in two. On the other hand, failure on any one car cannot impair the efficiency of the brake on the rest of the train.

The American brake company of St. Louis, Mo., exhibited full-sized working-models of a brake of this class.

Between the floor-sills, and at the inner end of the drawbar, is hung a bell-crank lever, *B*, which carries in one of its jawed ends the push-bar *A*, and, in the other, double-pull rods carrying a spiral spring transmitting the strain to bell-crank levers, *D*,*D*, suspended from the sills by hangers, *C*,*C*. The bell-cranks *D*,*D*, are connected to the brake-beams; and consequently compression on the draw-head acting on the lever *A* causes the brake-shoes to be pressed on the wheels, the amount of pressure being regulated by its transmission through the spiral spring. But, since a brake simply made as above described would not admit of a train being backed, a device is attached which removes the objection, and, further, only allows the brake to be applied when the car is moving at a speed above six miles per hour.

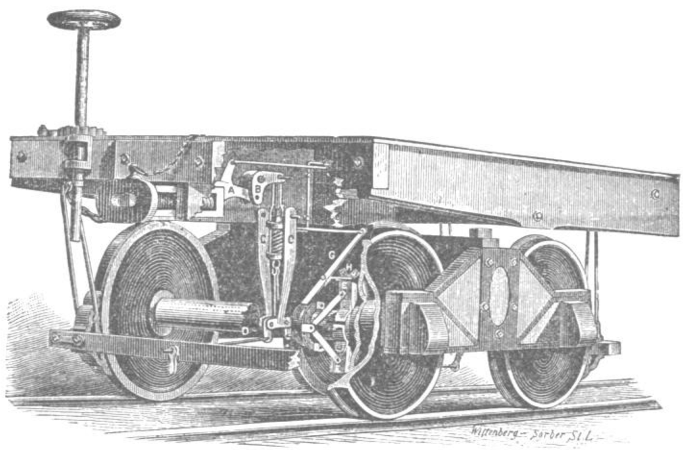
The push-bar *A* can only come in possible contact with the draw-head by the centrifugal force of governor-balls attached to the axle. These balls, *E*,*E*, are attached by means of links to a movable disk, *F*, encircling the axle. One end of a lever, *G*, bears against the disk, and the other end is connected by means of rods, etc., to the push-piece *A*. When the car is running at speed, the governor-balls draw the disk towards them, leaving the lever *G* free to follow it, and permitting the push-bar *A* to drop behind the draw-bar, when the brake is ready for action, going on directly the draw-gear is put in compression. When the speed falls below six miles an hour, the centrifugal force of the governor-weights becomes so feeble, that a spring (not shown in the illustration) restores the disk to its former position, lifting the push-piece *A* clear of the draw-head.

The brakes can be released at any time by the engineer putting on steam, and giving a pull to his train; and the train can be backed from a state of rest without the brakes going on, the push-piece *A* lying on the draw-head, but being unable to fall behind it.

The engineer can apply the brake, when pushing the train, by momentarily applying the brake on the engine or tender, thereby putting the draw-gear in tension, and letting the lever *A* fall behind the draw-head. When steam is again put on, the consequent compression applies the brake.

This brake has been in use for some time on the St. Louis and San Francisco and many other railroads, and appears to give very satisfactory results; the wear being very small, while the first cost is low enough to allow of its extensive application to freight-cars.

The brake exhibited by the Tallman automatic car-brake company of New York also acts by the compression of the draw-heads, which force together two friction-wheels, one of which is keyed on the axle, and the other is geared to a drum winding up the brake-chain. A ratchet-wheel, which can be shifted by hand, prevents the brake from acting when the train is backed.



AUTOMATIC BRAKE.

The Waldumer electric brake company of Chicago exhibited a working-model of a very promising form of continuous brake, which is just emerging from the experimental stage. The weak point of all continuous brakes has been the conveyance of the operating force — compressed air, vacuum, hydraulic power, etc. — along the length of a train, the pipes and couplings being generally expensive, and formed partly of perishable substances, while chains are unsatisfactory from every point of view. Many brakes that work well and promptly on a short train become slow and irregular in their action, when applied to a train of thirty or more vehicles. The instantaneous action of electricity, and the simplicity of the means used for its transmission, make it probable that an electric brake would be especially suited for long freight-trains. The brake is automatic, the fracture of wire or draw-gear ringing bells on engine and caboose, and warning both engineer and conductor that the train has parted, each being then at liberty to apply the brake or not, on his portion of the train, as he may deem best. Owing to the system of circuiting, the brake may be out of order on one car without affecting the rest of the train.

The street-car starter and brake exhibited by Charles T. Brown & Co., Chicago, is an ingenious device for storing the momentum which is destroyed by the usual form of brake, and utilizing it for restarting the car. The motion is not checked by friction, but by the axle, which, through suitable gearing, winds up a spiral spring, the power of which is available to again put the car in motion. The mechanical details appear well worked out, and the car can be run in either direction, and stopped or started on either up or down grades. The heavy pull necessary to start a car is very severe on horses, and this invention would appear to be useful in saving much wear and tear of horse-flesh.

D. H. O'NEALE NEALE.

A HEARING OF BIRDS' EARS.[1]—I.

THE 'musical class' of vertebrates enjoy the sense of audition to a high degree. Otherwise birds would cease to sing. They are the only animals besides man whose emotions are habitually aroused, stimulated, and to some extent controlled, by the appreciation of harmonic vibrations of the atmosphere. Most birds express their sexual passions in song, sometimes of the most ravishing quality to human ears, as that of the nightingale, skylark, or blue-bird; and it cannot be supposed that they do not themselves experience the effect of music in an eminent degree of pleasurable mental perturbations. The capability of musical expression resides chiefly in the male sex; the receptive capacity of musical affections appears to be better developed in the female. There is, however, no anatomical difference in their ears. Quickness of ear is extraordinary in some birds, as those of the genus Mimus (mocking-birds), which correctly render any notes they may chance to hear, with greater readiness and accuracy than is usually within human compass; and it may be reasonably doubted whether any other animals than some of the world's greatest musical composers have a higher experience of acoustic possibilities than many birds possess.

Birds' ears have nevertheless a simple anatomical construction, in comparison with those of mammals. The auditory organ is decidedly of the reptilian type; and the arrangement of the parts is, on the whole, quite like that of reptiles. Thus, the cochlea, which in mammals makes from one and a half to five whorls (two and a half in man), is simply a strap-like prolongation from the vestibule, lacking modiolus, lamina spiralis, etc.; the stapes is the only perfected ossiculum auditûs; the incus is scarcely recognizable as such, and inseparable from the stapes; the malleus is immense, but outside the ear, furnishing the articulation of the lower jaw, of the zygomatic arch, and of the pterygo-palatal bar; the tympanic bone is represented at most by a few specks of ossification. There is ordinarily no external ear; the whole tympanic cavity is exposed on removal of the membrane, which lies very superficial; the eustachian tubes unite before opening into the pharynx; the periotic bone, constituting the otocrane or skull of the ear, is less compact and precise than the 'petrous portion' of the mammalian temporal bone, its three bony elements being more distinct; no mastoid portion is recognizable as such, but pneumatic cells of diploë are numberless, and there is direct passage of air from the ear into the hollow of the lower jaw; one of the semicircular canals invades the occipital bone. Other peculiarities will appear as we proceed with our description, in which comparisons will be chiefly made with the human ear.

Most birds have no external ear, in the sense of a fleshy conch or auricle. In bald-headed birds, the meatus externus appears as a roundish orifice at the lower back corner of the head, just above and behind the articulation of the lower jaw. In nearly all birds, the opening is hidden by an overlying packet of feathers, collectively termed the *auriculars* or ear-coverts, on simply raising and reflecting which the meatus is exposed. The auriculars are peculiarly modified feathers, having loosened barbs, doubtless to lessen interference with the passage of sound. In a few birds the border of the meatus develops a slight tegumentary fold, partially occluding the orifice. In various owls, as of the genera Strix, Aluco, Asio, Nyctala, but not even throughout this group of birds, an immense tegumentary *operculum*, or ear-cover, is developed, which flap shuts down upon the ear-opening like the lid

[1] Complementary to the article entitled 'The nature of the human temporal bone,' *Journal of otology*, January, 1882. Some portions of that article may perhaps be made clearer by the present one, especially those relating to the parts of a temporal bone as elements of mandibular and hyoidean arches. Figs. 1–4 are borrowed from Prof. W. K. Parker's admirable essay on the development of the fowl's skull, in Encycl. Brit., 9th ed., art. Birds; figs. 5–9 are from Prof. I. Ibsen's beautiful memoir, as cited in the text.