to discharge their contents into the air merely in order to allow people to witness the spectacular display, which attracted crowds from the vicinity and advertised the region throughout the country. It would be impossible to estimate the immense quantity of oil which was wasted in this way, for no effort whatever was made to force the supply into tanks or even earthen reservoirs. It spread over the surface of the ground, filling the natural depressions in the prairie and even covering the beds of streams in the vicinity. It was stated that some of the great wells, like the Lucas gusher, flowed fully 50,000 barrels in 24 hours, but as there was no means of gaging the flow, these statistics are merely guesswork. There is no doubt, however, as to the enormous quantity which was wasted, probably aggregating over a million barrels.

After the flow had been controlled and the work of providing storage for the fluid was under way, months elapsed before sufficient reservoir capacity was afforded to provide for the yield, while the pipe lines to the seacoast were not finished until nearly a year after the discovery of the Spindle Top field. Not only were large tanks of sheet metal constructed, but reservoirs dug in the prairie and surrounded with merely earthen embankments to keep the oil from escaping. While some of these were served by pipe lines, a very large quantity of the oil was conveyed to them through narrow trenches dug in the prairie, ranging from a foot to four and five feet in width and from two to six feet in depth. They were not completely filled with oil, but such a proportion of the overflow from the wells was diverted to them that the quantity conveyed in these ditches at times was far more than that carried by the pipe lines. One of the earth reservoirs, known as the "Higgins," covered several acres in extent, and in fact was a lake of oil, in some places being nearly twenty feet in depth, while tanks were built ranging from 1,000 barrels upward.

Such has been the abundant yield of the fluid that gross carelessness has prevailed, especially in the Spindle Top district, in husbanding the supply. Much of the oil has escaped through leaks in the trenches; the pipes have frequently burst, discharging their contents over a large area, while many of the tanks have been so hastily constructed that they were not tight. In short, the oil has saturated everything, and merely the flame of a match thrown upon the ground has been sufficient, in several instances, to start disastrous fires. The first great fire in the Texas field is said by people in the vicinity to have been caused by a man going into a settling tank with a lighted lantern, the door by which the wick was ignited being carelessly left open. The flames coming in contact with vapor in the tank caused an explosion which immediately set fire to the interior. Another explosion threw burning oil against several derricks, which ignited, according to the statements of spectators, as if composed of tinder. Sparks were carried to a 4,000-barrel reservoir, which, in a few hours, was reduced to a mass of twisted metal. This fire practically destroyed property covering ten acres of the most valuable territory, and raged for two weeks. The greatest fire in the history of the Texas field was undoubtedly that in what is known as the Hogg-Swayne tract, which occurred in September last. At one time fifty wells were ablaze, and over one hundred derricks were destroyed, while twenty workmen employed in the vicinity lost their lives before they had time to escape.

The great damage done by the first oil fires in the Southwest was in a measure due to the ignorance of the best means of fighting them. At first water was tried, but it merely made matters worse by spreading the burning liquid, having no effect whatever in extinguishing it. Then earth was used to confine the flames to a certain district. The "Ten-acre fire," as it is still called, was finally confined in this manner, several hundred men throwing up a bank of earth about the burning area which kept it from spreading to other portions, and finally the fire became exhausted for want of material on which to feed, when the embers were smothered by shoveling earth upon them. Soon after the drilling of the first gushers at Spindle Top, fire broke out during an exhibition near one of the small derricks. Fortunately it was extinguished by the spectators, who realized the great danger, and not only threw earth upon it but in some instances stamped it out with coats and blankets.

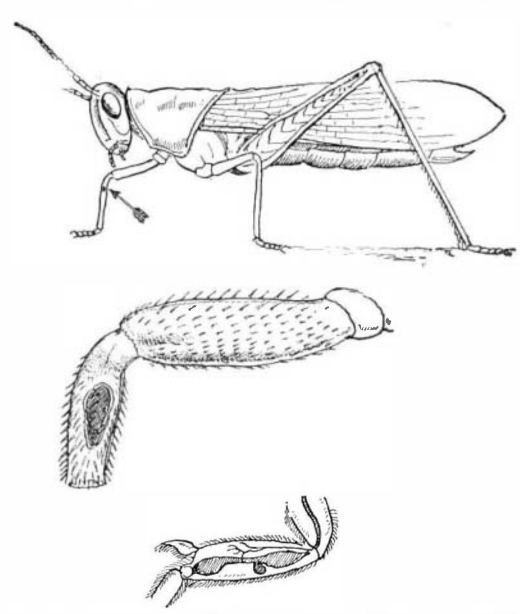
In recent attempts at fire fighting in Texas and Louisiana, however, steam has been used to good effect, and it appears to be the only effective means of extinguishing oil flames, as the earth is useless except after the fire has died down sufficiently to allow the shovelers to approach closely to the burning area. It was first tried near Beaumont by John Ennis of that city, the steam being applied through an iron pipe hastily laid and connected with the boiler of a portable engine removed to a safe distance from the fire. After the Jennings fire had raged for over two weeks Mr. Ennis was sent for to plan some means of extinguishing it, for, on account of the quantity of oil in the burning wells, it threatened to continue indefinitely. The nearest towns were searched for boilers which could be brought to the location, and twelve were secured in all, ranging from 20 to 30 horse power. They were set up in a semi-circle and a group of three or four connected to lines of iron pipes, which were laid to points as near the burning area as the men could venture in safety. Then fires were lighted in the furnaces and a full head of steam generated, which was turned upon the flames in jets. One group of boilers was continually held in reserve, so that its jet could be used when it was necessary to suspend operations in another group. In this way steam was continually applied to the fire for several days until the flames were so reduced in volume that they could be smothered with earth. Since then steam has been used in a number of instances, but in the Jennings fire the horse power of the combined boilers was far greater than in any other case.

ARE THE SENSES OF THE LOWER ANIMALS SUPERIOR TO OURS?

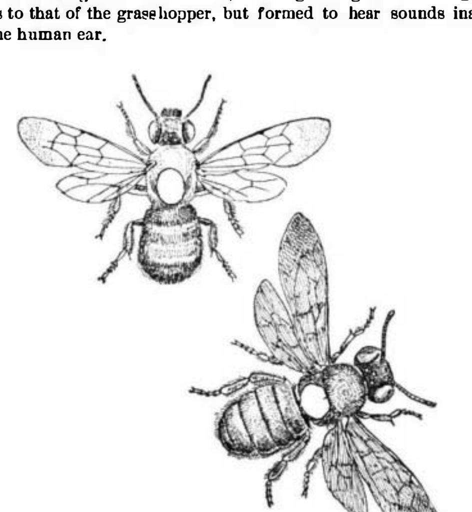
BY J. CARTER BEARD.

It will at once be recognized that as we can possess no other knowledge of external things than that founded upon the reports which our five senses elect to bring us, our information must necessarily be bounded by their limitations.

Head of Bat (Mormopos blainvilli) showing peculiar sense organs.



Upper figure.—Grasshopper, whose ear is in his foreleg. Middle figure.—Ear of grasshopper, showing thigh and part of the tibia containing the ear. Lower figure.—Tibia of ant, showing an organ of hearing analogous to that of the grasshopper, but formed to hear sounds inaudible to the human ear.



Male and Female Mason Bee, marked with a drop of white paint for identification.

But, although we cannot have any true or adequate conception of sense discernments belonging to regions beyond the powers and jurisdiction of our own perceptive faculties, we know that such regions exist, and it is demonstrable that they are, in certain cases, to a greater or lesser extent, accessible to many of the lower animals.

It is not easy perhaps to appreciate, in any just degree, the imperfectness of the few faculties we possess of perceiving external things, until a comparison is made between them and the perceptive capacities developed in other animals.

A multitude of living creatures, far below us in the scale of animated existence, might justly consider our senses, as contrasted with those they themselves possess, the veriest rudiments of such powers; an osprey, for example, which from the height of more than a hundred feet discerns beneath the wind-roughened water fishes no larger than the palm of a man's hand, and accurately measures with its eyes the distance its quarry swims beneath the surface; a barn owl, which chases and captures in the dark, bats whose irregular flight your eyes can hardly follow in the early twilight, would doubtless, could it compare our power of vision with its own, appraise it at so low a rate it might be scarcely worthy of the name; a bat, whose wonderfully constructed microphonic ears, nerve-netted wings, and strange foliated face organs, enable it, without coming in contact with the objects shrouded in utter darkness, to perceive and avoid them in its flight, must necessarily, could it know the extent of our powers of hearing and of our tactile sense, consider them extremely deficient; or a dog, which can unerringly select by its sense of smell any one particular duck out of a hundred, were he able to contrast the olfactory capacities of men with those of dogs, might have reason to pronounce the former almost entirely lacking.

The careful study of the sense organs of the lower animals and of the functional power and character of such organs, which has now been carried on for a number of years, has arrived at results that are not only very interesting in themselves, but which form extremely valuable and important data in the sciences of comparative physiology and psychology.

There is a wonderful analogy between the way in which waves of sound affect the ear and the way waves of light affect the eye. A ray of sunlight shining through a prism, and separated into the succession of colors called the spectrum, is only visible in part to human vision. Below the red at one end, and above the violet at the other, as we all know, are rays which are invisible to us.

The lowest tones audible to us correspond to the red end of the spectrum. Like the waves of light which constitute the red rays, those which fall upon our ears as the deepest are the slowest, while notes answering to the rapid, luminous vibrations composing the violet rays, are the lightest and shrillest the ear can distinguish. The possibilities of human color vision are limited to the seven rays of the spectrum, and those of human hearing to sound waves of between thirty (the slowest the ear can distinguish) to forty-five thousand to the second. Beyond these limits we are blind and deaf to sensations, of the existence of which, although our eyes and our ears are not of a nature to distinguish them, there can be no doubt.

A series of experiments was made, several years ago, with light of different wave-lengths on ants, to discover, if possible, whether or not the limits of vision in these insects were the same as in ourselves. After a number of observations demonstrating the fact that ants are sensitive to the ultra-violet rays which lie beyond the range of our vision, the question arose how two media, identical in color to our eyes, but one of which transmitted and the other intercepted the ultra violet rays, would affect the ants. A solution of iodine in bisulphide of carbon, and also one of roseine, carmine and indigo, combined in such proportions as to produce the same shade of the same color as the former, were prepared. To human sight the two liquid solutions were identical; but, in point of fact, the ultra-violet rays, shut out by the bisulphide mixture, passed freely through the other. Exactly equal quantities of these solutions in flat-sided glass bottles of the same size and shape were placed over a nest of the European black ant (*Formica fusca*). In no less than twenty observations the ants showed so decisively a power of discriminating between the two, and so decided a partiality for gathering under the bottle which shaded them from the ultra-violet rays, that no doubt remains that a radical difference between the two solutions was recognized and sensibly felt by them.

This series of experiments, taken in connection with many previously made and described, shows conclusively that the limits of vision in ants are not the same as in ourselves.

Now as every ray of homogeneous light is seen as a separate color, rays of light beyond the violet must reveal to ants a color differing from any we know, as these differ among themselves, a color of which we can form no conception.

Again, as the combination of all the colored rays visible to us in the spectrum makes our white light, it must necessarily vary from the white light seen by these insects, because it wants the supplementary color which they are, but we are not, able to perceive; and as there are few objects in nature in which the blending of several colors does not occur, it is evident that by adding another to the three primitive color elements, red, blue and yellow, we must obtain radically different color effects than any we have ever seen, and that this must make objects look very different to ants from what they do to us.

Many insects, unable to produce sounds which we can distinguish, possess nevertheless sound-producing apparatus, and elaborate organs of hearing analogous to those belonging to other and in general larger species, quite capable of making themselves heard. It is certain that a number of species of animals hear sounds that we cannot hear.

Arthropods in general are indifferent to ordinary sounds. It is possible the compass of hearing possessed by some animals lies in the range of air vibrations above our own, that they can hear no sounds as low as the highest note that is audible to us, as we can hear none as high as the lowest that is audible to them.

But it is without doubt the sense of smell, if indeed we may believe that all the phenomena credited to this sense properly belong to it, which attains its greatest development among insects. Professor N. S. Shaler, of Harvard University, asserts that a female gypsy moth (*Ocneria dispar*) will, by an odor so subtile as to be imperceptible to human olfactories, "attract males from the distance of about a mile away." Albrecht Bethe, the German entomologist, states that a male moth (species not stated) has been known to locate a female several miles distant. Prof. Jordan, president of the Leland Stanford, Jr., University, writes: "In the insectory a few years ago, a few females of the beautiful Promethia moth (*Callosamia promethia*) were inclosed in a box which was kept inside of the insectory building. No males had been seen about the insectory nor in its immediate vicinity, although they had been sought for by collectors. A few hours after the beginning of the captivity of the female moths, there were forty male Promethias fluttering about over the glass roof of the insectory. They could not see the females, yet had discovered their presence in the building.

The sense of smell is most nearly allied to that of taste. Hearing and seeing depend upon nerve responses to vibrations in the air and in the ether. In order to taste a substance, it has to be wholly or partially dissolved; in order to smell a substance, it must encounter the olfactory organs as a vapor, an emanation, a cloud of particles arising from odoriferous matter. An odorous substance can be readily inclosed so that little, if any, odor escapes.

Now in the first instance adduced, a cloud of imperceptible odor arising from an odor-producing organ, situated somewhere about the body of a little insect an inch long, spreads on every side for "about a mile" at least, and is dense enough at that distance to affect the sensory organs of the male moth.

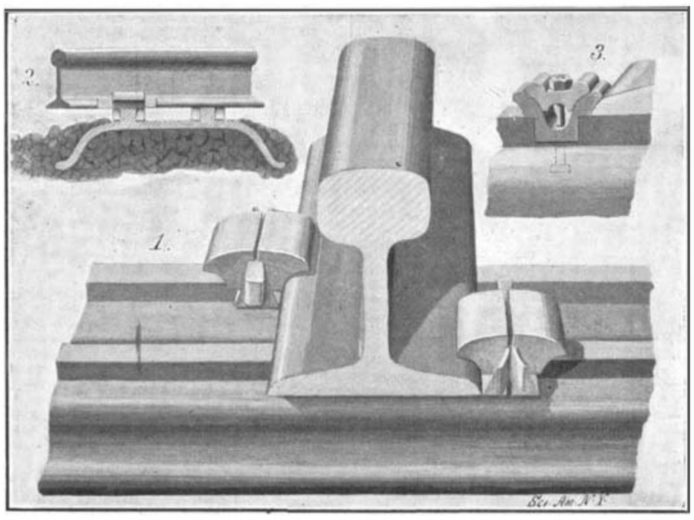
In the second instance adduced, the cloud extends to the distance of several miles without losing its virtue; and in the third, it not only penetrates through the box in which the female insect is kept inclosed, but also the glass roof of the insectory and extending outward to an unknown distance, mingled with, perhaps, as many as a million stronger odors, meets the male moths, which are able to differentiate it from all others, and to know the exact direction from which it comes.

Many animals can follow a scent trail left by another upon the surface of the ground; but to follow unerringly to some distant point in space, from which it arises, an odor extending indefinably in every direction in the air, is a very different proposition.

ONE OF THE LARGEST TREES IN THE WORLD.

BY WALTER L. BEASLEY.

The American Museum of Natural History has now on exhibition one of the largest sections of a tree ever brought from a forest. The fast passing away of the big trees, the majestic relics of the forest primeval and prehistoric times, due to the ax of the commercial lumberman, is rapidly going on, and it will only be a question of time when all save those in government and State reservation groves will be cut down. Recently the government sent an expert forester and secured a magnificent cut from one of the giant Sequoias of the King's River area, Southern California. The tree stood over 300 feet in height, and measured 90 feet at the base. A section 20 feet above ground was obtained 4 feet thick and weighing 50 tons. The diameter of the block is a little over 18 feet, and its circumference measures 56 feet. The specimen is highly polished and will be the main feature of the new wing of the Forestry Hall. Prof. H. C. Bumpus, Curator of the department, has illustrated the life-history of the tree in a striking and unique manner, by placing tags marking every hundred years of growth, which is estimated from the cross-section concentric rings. In addition the great events and happenings in geology and other sciences are likewise recorded in these rings. The tree began to grow 550 A. D., and was 13 feet in diameter when Columbus reached our shores. Some of the trees in the same vicinity are said to be from five

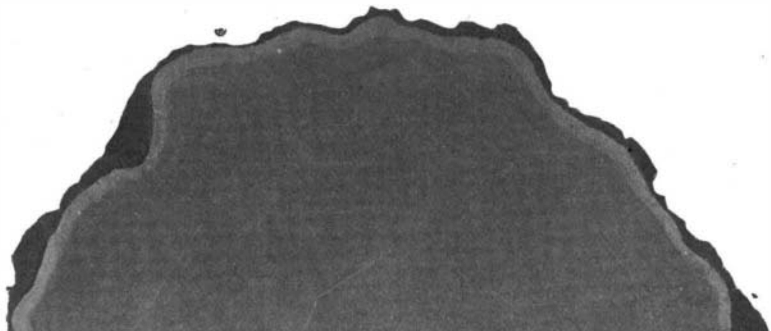


RAILWAY TIE AND FASTENING.

to eight thousand years old. Forest experts have estimated that a tree of this size contains 750,000 feet of lumber, which being cut into telegraph poles 8 and 9 at the base and 4 and 5 at the top, and 24 feet high, would make one pole forty miles long, or enough to supply a telegraph line from Kansas City to Chicago.

RAILWAY TIE AND FASTENING.

A new steel tie that may be readily formed by rolling and then drop-forged into shape, is illustrated in the accompanying engraving. The tie is adapted to be used in connection with a very simple device, by means of which the rails may be quickly and securely fastened. A patent for this invention has just been granted to Mr. G. W. Schellenbach, of Joplin, Mo. The tie has the shape of an inverted trough, so that dirt or ballast may be packed underneath the same. On the top of the tie along opposite sides are ribs provided each with an opening to receive the fastening device. The opposite walls of these openings are undercut, and the fastening devices consist of two


SECTION OF ONE OF THE LARGEST TREES ON RECORD.

jaw portions having the outer sides of their bases inclined to engage with the inclined walls of the opening. These jaws have shoulder portions for engaging on the upper face of the rib. The outer sides of the jaws are made hook-shaped to engage the base flanges of the rails. Of course, only one jaw of a pair will be engaged with the rail, but it is preferred to make the two jaws of similar shape, so that should one become worn, the device may be turned and the other jaw engaged with the rail. After placing the fastening devices in the openings, wedges are forced in between the jaws. The wedges are split at the thin ends so that they may be bent outward to prevent accidental disarrangement. It will be noticed that the act of driving in the wedge results not only in an expansion of the fastening device in its socket, but also in a downward pull of the jaws which serves to clamp the rail down on the tie. These fastening devices are illustrated as short pieces not much longer than the width of the rib on the tie. However, if desired, they may be made sufficiently long to engage in opposite openings or opposite ribs. Obviously by this invention, a rail may be quickly fastened in place and very little packing will be required at the outer sides of the tie. To reduce noise a block of wood may be placed between the rail and the tie. The fastening thus arranged combines great strength and elasticity and is practically indestructible. No spreading of the rails can occur. In Fig. 3 we show a modification of the fastening device consisting of two jaws connected at the bottom by a cross-piece. The jaws are held and slightly spread by means of a wedge arranged between them and forced down by a bolt passing through the tie.

Odd Uses for Rawhide.

It was the great packing and killing houses of Chicago which helped to bring about the present uses of rawhide, says the New York Sun.

Rawhide is a form of leather in which the curing process stops far short of destroying the life of the material. The result of this treatment is a product remarkable for toughness, durability, tensile strength and pliancy. It is used for belting, rope, hydraulic packing, laces of various kinds, pinion wheels, washers, harness, mauls and mallets, flynets, trunks, saddles and artificial limbs.

Rawhide rope is handsome and astonishingly strong, besides having great power of resistance when exposed to the action of the weather. At a little distance it looks like very white and clean new hempen rope. It is delightfully supple, and once tied it holds for a lifetime. The cost of such rope puts it beyond the reach of most consumers, yet for some purposes it is the cheapest material that can be used.

It costs from 10 or 12 cents to more than $2.75 a foot, according to diameter and quality. The cheapest is about a quarter of an inch in diameter; the most expensive, save that made to order in special sizes, is two and a quarter inches diameter. It is largely used for the transmission of power, especially where the line of transmission is long and indirect. Only a close examination brings to light the points where strands are joined, and splicings are so made that they show no change in the diameter of the rope.

One of the most curious applications of rawhide is to the manufacture of pinion wheels for the transmission of power. Such wheels are usually made of iron or steel, but the rawhide can be made sufficiently rigid, hard and tough to serve all the purposes of metal in such articles. The rawhide pinions are almost noiseless, and they require little lubrication. A somewhat similar use is in the gear of friction wheels.

Mallets and mauls of rawhide are used for a variety of purposes in manufacturing. The former are entirely of hide save the handle; the latter have a wooden or metallic base with a rawhide face. Hammers with rawhide faces are also made.

The old-fashioned rawhide whips, the "cowhide" of many a social and political row, are made in several forms, as are blacksnake whips of the same material, rawhide lashes, and miners' whips. Rawhide lariats are also manufactured, though there was a time when every plainsman made his own. They cost from 15 to 20 cents a foot, according to diameter and form of pleat. They are rarely seen east of the Mississippi save in the factories.

In order to determine the density of the earth, President F. W. McNair, of the Michigan College of Mines, and Major John F. Hayford, of the U. S. Coast and Geodetic Survey, will conduct experiments at the Tamarack mine, which is particularly well fitted for this purpose, since its shaft is one of the deepest in the world, penetrating to a depth of 4,550 feet in strata of uniform density. The density of the earth is largely a matter of scientific conjecture. It has been computed by formulæ based on Newton's laws of gravitation. It is true that Sir George Biddel Airy, the British Astronomer Royal, computed the earth's density from experiments which he carried on at a Welsh colliery, but the figures which he obtained varied so much from those based on the formulæ that they have not been generally accepted.

The Rome-Paris telephone line was opened to the public in the beginning of December. The trials were most successful. The line is the longest in Europe, covering as it does 1,000 miles.