is carefully attended to, and the most recent improvements which experience could suggest, have been adopted to meet the exigencies of street-car service.

The motors have the regular Sprague mounting, as shown in the illustration, being centred on the axles, and flexibly supported to prevent accident from sudden strain. They are very compact and powerful, and combine the requisites of lightest weight possible with highest efficiency. Without this flexible suspension for both directions of running, it is hard to imagine how a motor can be successfully applied to street-cars and fulfil all conditions of actual experience.

Only one intermediate is used between the armature pinion and the main gear. The gear upon the intermediate, which meshes into the main gear, is built of vulcanized fibre, making it absolutely noiseless, is so constructed that it is very durable, and it will outwear the steel teeth which mesh into it.

All the bearings are self-oiling and completely dust-proof, and should run at least a month with little or no attention, and each is so constructed that it can be removed without dismounting the machine. The brushes are on an entirely new principle and design, and are remarkable for ease of adjustment, and work with equal facility in running either forward or backward. By their means a perfect electrical contact is secured, without excessive pressure on the commutator, and all wear is reduced to a minimum.

The whole motor and the gearing, and all parts, are so placed that they can be perfectly shielded and shut in by a tight-fitting cover, so that by this means it is rendered impossible for moisture or dust to get into any of the working parts.

The design and construction of every part of this truck are not only to have each detail as strong as possible, but also to have it readily accessible, and to reduce all care and attendance to a minimum.

We congratulate the Sprague Company upon the success which has attended their installations in the past, and we anticipate for them an increased success in the future.

SCIENTIFIC NEWS IN WASHINGTON.

How Birds soar: the Conditions of the Atmosphere, and not a Peculiar Structure of the Bird, the Essential Factor. — How Men of All Ages and in Every Country have made of Themselves Beasts of Burden. — How the Navajo gamble.

The Soaring of Birds.

WHOEVER has watched an eagle or other soaring bird as he circles through the air has marvelled that he is able to sustain himself without the flapping of his wings. Not only does he do this, but he rises higher and higher from the earth, enlarging his circles and seemingly increasing his speed, until he attains so great a height as to be almost invisible. This apparent defiance of the laws of gravitation has long been recognized as a problem to be solved, and many explanations have been offered. The latest contribution to the subject is by Mr. G. K. Gilbert, who read a paper to the Philosophical Society of Washington at its last meeting. He concluded by saying that when he proposed to the society's committee to place the paper on its programme, he supposed his theory of soaring to be novel, but that he had since found himself anticipated by Lord Rayleigh, who communicated the same explanation to *Nature* in 1883 (vol. xxvii. p. 534), and by Mr. Hubert Airy, who independently reached the same result at about the same time (*Nature*, vol. xxvii. p. 590). It appeared, however, from the informal discussion which followed the reading of the paper, that the earlier presentation of the theory had escaped the attention of many ornithologists and physicists present, and it may therefore not be amiss to restate it in the pages of *Science*. The following paragraphs are extracted from Mr. Gilbert's paper.

"The soaring bird, with wings expanded, is formed so as to move forward with little friction, and downward with great friction. We may conceive him as having two coincident motions, — a forward motion, initiated by muscular action; and a downward motion, slow but continuous, under the pull of gravity. By variations of the attitude of his wings and tail, he can and does control the direction of his forward motion.

"If the forward component of motion is horizontal, the resultant of the two motions is obliquely downward. In order that the resultant may be horizontal, it is necessary (1) that the forward component be directed obliquely upward, and (2) that it exceed a certain minimum amount.

"However small may be the friction created by the forward motion, it is not *nil*. It constantly tends to check the motion; and, unless the energy it consumes is in some way replaced, the forward motion is eventually so reduced that horizontal motion cannot be maintained.

"It is proposed to show that the needed compensatory energy may be derived from the differential motions of the air.

"I shall not dwell on the utilization of upward currents of air. It is evident without explanation that when a bird sails through air that is rising, whether vertically or obliquely, he is carried upward with the air, and, if the upward motion of the air equals or exceeds the downward motion of the bird under gravity, he does not need to flap his wings in order to sustain himself. But such opportunities are of exceptional occurrence; and, while it is highly probable that they are not neglected, recourse to soaring is too frequent, and with certain species too generally successful, to permit us to believe that an upward current is its necessary condition. I shall confine my attention to the less obvious resource of horizontal currents.

"It is frequently observed that the velocity of the wind increases from the ground upward. Let us assume, for simplicity's sake, that the air-currents above and below a certain horizontal plane have the same direction but different velocities, the upper moving the faster by a certain amount, i. A soaring bird is moving through the lower air in the opposite direction, and the bird's velocity with reference to the air is V.

"It should be borne in mind that velocity is merely rate of relative motion. Fully to define the velocity of a body, it is necessary to state to what other body its motion is referred. In this case the velocity of the upper current with reference to the lower current is i; the velocity of the bird with reference to the lower current is V; and, since the bird and the upper current pass the lower current in opposite directions, the velocity of the bird with reference to the upper current is $V+i$.

"Now let the bird change his course, turning obliquely upward and passing into the upper current. His velocity with reference to the air in which he is immersed is at once increased from V to $V+i$. Next let the bird wheel, to the right or to the left, until the direction of his motion is coincident with that of the wind. His velocity with reference to the upper current is still $V+i$, but the reversal of his direction has changed his relation to the currents. He is passing the lower and slower current more rapidly than he passes the upper, and his velocity with reference to the lower current is greater by their difference: it is $V+2i$. Now let him descend obliquely, and enter the lower current. His velocity is not affected by the transfer. It is still $V+2i$, referred to the lower current. Finally let him wheel in the lower current until his direction is once more directly opposed to that of the wind. The cycle of evolutions leaves him with the velocity $V+2i$, referred to the lower current, in place of his initial velocity V, referred to the same datum. He has gained a velocity $2i$, or double the velocity of one air-current referred to the other, and he has resumed his original relation to the currents. Manifestly he can repeat the process indefinitely.

"Add now that the velocity thus gained is the required compensation for the velocity lost by friction, and the essence of the theory is stated."

Mr. Gilbert then proceeded to pass from the special case assumed for the sake of simplicity to the more general case, pointing out that certain assumptions which facilitated the statement of the theory were not essential to the analysis. Provided the air in the region traversed by the bird has some differential motion in a horizontal sense, and provided the bird regulates his circling course so as to ascend when his direction of flight is opposed to the direction of the differential motion of the air into which he rises, and so as to descend when the relations are reversed, he will acquire from the differential motion of the air an acceleration of his own velocity. If this acceleration is less than the concurrent loss by friction, he cannot sustain himself by soaring alone; but, if it equals or exceeds that loss, he can sustain himself indefinitely.

After a discussion of various qualifying factors, it was stated that when the orbit of the bird is circular, and lies in an inclined plane rising toward the wind, and when the horizontal velocity of the air diminishes uniformly from the highest point to the lowest point of the orbit, the velocity gained by the bird in making the circuit is equal to the differential velocity of the highest and lowest layers of air traversed, multiplied by $\frac{\pi}{2}$ into the cosine of the angle of inclination of the plane of the orbit.

It was especially insisted that the theory does not propose to make something out of nothing, but appeals to a transformation of existing energy. "The differential motion of air-currents is a true store of solar energy, and the circling of the bird through the two currents enables him to draw on that store. The process is essentially homologous with the utilization of the relative motion of air and ocean for the sailing of a ship, and with the turning of a mill or the flying of a kite by means of the relative motions of air and ground or of air and boy; only in the case of the bird the apparatus is not in continuous contact with both members of the motive couple, but passes to and fro between them. The function of the kite-string is performed by the inertia of the moving bird."

It is evident, that, if this explanation is sufficient, soaring is impossible without differential motions of air, and is therefore impossible when the air has no motion; if it is sufficient, the circling of soaring birds is not merely habitual, but necessary; and if it is sufficient, observation should show that their circles are higher on one side than on the other.

Human Beasts of Burden.

Prof. Otis T. Mason has been many years engaged in the collection of material for a monograph or book upon the subject given above, and now has, systematically arranged, descriptions of several hundred different modes by which human beings, in civilized and savage countries, make themselves the vehicles for the transportation of burdens. Each of these he has had illustrated by a drawing, so that the whole is not only of the highest ethnologic value, but will be exceedingly interesting to the non-scientific reader.

At the last meeting of the Anthropological Society of Washington, Professor Mason read a paper in which he described some of the more common ways in which man has made himself a beast of burden. The brief abstract given here presents some of the more salient parts of the paper.

In his prefatory remarks, Professor Mason explained that this was a subject that had awakened his deepest interest, and that the paper he presented was but an introduction to other researches by means of which he proposed to fully investigate and demonstrate the growth of commerce as carried on through the agency of the human body. That the aboriginal inhabitants performed great feats in the way of transporting materials is shown by the co-existence of raw copper on the shores of Lake Superior, and manufactured copper implements in the remains of the mound and cave dwellings in the southern part of the country. The same thing is true of the presence of wrought jade, which is found in China and in the Swiss lake-dwellings. Men and women were the first beasts of burden, and it is undoubtedly true that all aboriginal carrying was done on their heads and backs.

Even the improved state of civilized society has not extinguished all traces of this, for human carriers are still numerous. Hod-carriers have but recently, and indeed but partially, been superseded by elevating machines. The great progress of the time has been such, continued Professor Mason, that no one walks nowadays unless it is a preferred exercise: horses, steam, and electricity lend their aid to whirl people to their destinations. It is considered vulgar to carry a parcel: the humblest servant-girl, buying a few cents' worth, may have her purchase taken home in a special-delivery wagon covered with forty coats of lacquer. It has been calculated that two million tons are constantly worn by the human race in the way of dress and ornament.

The paper then enumerated the various methods by which the various beasts of burden perform their carrying-tasks; first of all, the hand, — the right hand. In speaking of this, Professor Mason said that he has examined a great number of savage implements designed to be carried in the hand, and that the proportion of those shaped for use by the left hand was not greater than 1 to 50. In no case did he find a left-hand female implement. Then both hands are used, after which the fingers come into play. As an illustration of the use of the fingers in carrying, Professor Mason mentioned the summer-resort waiter, who bears his tray aloft on three fingers. The baldric is next in order, slung over the shoulder by a strap, and hanging on the hip. In this way hunters carry game, and travellers carry small satchels. Then, still progressing, goods to be carried are hung to a belt. Hanging things on the arm may be called the retail method of carrying, and is used by farm-hands, servants, porters; in fact, by a large proportion of the people we meet in any place. While a civilized being will twist his form so as to get the load that is hung on his arm supported by his back, a savage will never be found doing so. Next comes the hanging over the shoulder, of which a good example is the universal sack of the negro vagabond, containing unclaimed property and other people's chickens. This method is used by grain-porters and hod-carriers.

The Oriental porters carry almost exclusively on their shoulders. A cooly's average load is a hundred pounds, with which he can make thirty miles a day. It is estimated that there are a million tons of material moved by coolies in China each day. Then both shoulders come into use, the load being placed round the neck; after which an easy progression is to the back, which is the natural carrying-place of the burden. The soldier, carrying his knapsack and rations, is a good example. Then loads are carried on the heads, — a process called 'toting.' The negro is a domestic example, and dairy-maids are reputed to carry their milk-pails on their heads, and there are many other illustrations of this mode of transportation. Certain tribes of Indians wear straw rings on their heads to aid in bearing and balancing these great loads. Pockets, remarked Professor Mason, are scarcely worth mentioning as a civilized means of transportation, although the flowing robes of a Chinaman are capable of concealing at least half a bushel of playing-cards, — a capacity that deserves passing notice.

The carrying-power given by these various modes is augmented by means of combinations of men, in illustration of which the vast works in Egypt and other Eastern countries were cited. Men also carry goods by traction; that is, by drawing over the ground. First the arm alone is used, then a line is fastened to the object and to the person. It is held in the hand over the shoulder, or wound over the waist or over a pole. The hunter drawing home his game is a primitive example of this means of carrying. Throwing is sometimes resorted to as a mode of transportation, of which the negro method of handling watermelons by tossing them from hand to hand is a fair example. Dirt and excavated material were at first carried in sacks, which have been superseded by shovels. The great necessities and the differentiating processes of civilization for rapid and safe transportation give rise to the professional carriers, among whom may be mentioned carriers, messengers, mail-men, and pedlers. For much of this excellent abstract, *Science* is indebted to the Washington *Evening Star*.

A Queer Game among the Navajo.

'Navajo Gambling Songs' was the title of a paper read by Dr. Washington Matthews at the last meeting of the Anthropological Society of Washington.

The Navajo Indians, he said, have numerous songs, many of which are sung during the progress of a gambling game called 'kesichay' (this spelling, Dr. Matthews afterward explained, will suffice). The game is founded on a myth which forms one of the traditional beliefs of the Navajo. The songs used in this game are almost numberless; and one old man of whom the doctor asked the number, said, with an intended exaggeration, that there were over four thousand in the game. Another said that there was a song for every bird that flies, every animal that crawls or prowls.

The game is sacred, and is usually played in winter, and always in the dark hours. When asked why the night should be selected for the game, one Indian remarked that "he on whom the sun shines while playing the kesichay will be stricken blind." The game is played in a lodge or wigwam. Six moccasons are buried with their tops even with the ground, in two rows several feet apart, and filled to their edges with sand.

The Indians divide into two parties, and draw lots for the first move. The winners of the move take a small black stone, and, raising a blanket between themselves and their opponents to conceal their operations, hide the stone in one of the moccasons, burying it in the sand so that it is entirely out of sight. The others then try to find the stone by striking with a stick the moccason supposed to contain it. If they find it, they take the stone in turn and hide it, the others guessing; but if they fail, their opponents hold it until it is found, each time hanging up the blanket, and changing, or pretending to change, its location. The game is counted by means of a hundred and two long slender sticks on each side, which change hands as the sides win or lose. The system of counting is very intricate, the count depending upon the location of the ball. Four, six, or ten counters change hands at each hiding. The chances are almost all in favor of the holders of the ball; and frequently one side will lose all of their counters before the ball is found, when the game comes to an end. Two of the counters on each side are notched, and are called 'grandmothers.' When there has been a long run of bad luck, the 'grandmothers' are stuck up in the ground and told to go and seek their grandchildren, meaning to bring back the luck and the lost counters. It is supposed to be lucky to hold the 'grandmothers' until the last: so they are not laid out until the others are all gone.

The myth on which the kesichay is founded is based, like most other Indian traditions, upon the sayings and doings of animals in those ages when the world was supposed to be peopled entirely with beasts. There were some animals, the tradition runs, that saw better, hunted better, and were happier, in the light, and others that liked the dark. As it was thought wise that the existing alternation of night and day should be changed so as to suit one or the other of these classes, it was determined to call a council of the animals to determine in whose favor the change should be made. When all were together, they decided to play the kesichay to settle the controversy. The council was held at night, and the game progressed with varying success for many hours. During the play the animals of either side began to sing songs illustrative of their luck or their feelings, sometimes taunting each other with their ill success. Every animal present sang of his own characteristics, and so the foundation of the present animal songs of the kesichay was laid. When the blanket is put up, the holders of the ball sing a chant to the effect that "the old screen hangs in front, the old screen hangs in front," repeated many times. The bear, the dog, the owl, every bird and animal known to the Navajo, has some appropriate song that is sung in the game.

The game between the nocturnal and the diurnal animals developed into a round of taunting songs, flung from one side to another, until some one called on the raven. He sang a song of the morning, and cried that the dawn had come, when the eastern sky began to be filled with light; and with a mingled cry of disappointment the nocturnal animals fled to their homes, scattering the articles used in the game, which was thus brought to an undecided end. For this reason the alternation of night and day has never been changed.

The moccasons used belonged to the bear, who, in his hurry, put them on wrong, thus giving his feet their peculiar shape. The sun shone on him before he reached his den, and turned his black coat to a reddish brown, which is its color now.

A Navajo Indian will not kill a snake, but, if one is encountered, will put a stick beneath it and toss it away: so, if a snake come into the tent where the kesichay is being played, it is tossed from one side to the other by the opponents, in the hope that it will bring bad luck to those with whom it stays.

ELECTRICAL NEWS.

The Use of Condensers in distributing Electricity.

TWO patents have been lately issued in which condensers are employed to reduce from a high to a low potential, in place of transformers or storage-batteries. One of these plans has been already described in this journal, and an objection to it was pointed out. Briefly, it consisted in charging a condenser of comparatively small capacity to a high potential, discharging it into a much larger condenser, thereby decreasing the potential, and finally discharging the latter through the lamp-circuit. This operation was continuously and rapidly performed. One objection that was pointed out lay in the great capacity that would be required for the large condenser. Another objection lies in the great waste of energy. The energy of the smaller condenser before it is connected with the larger is

$$\frac{1}{2}\frac{m^2}{c},$$

where m is the quantity of electricity on it, and c is its capacity. After it is discharged into the larger condenser, the energy of the two is

$$\frac{1}{2}\frac{m^2}{c+c_1},$$

where c_1 is the capacity of the latter. If we wish to reduce our potential from 2,000 volts to 100, c_1 must be $19\,c$, and the energy in the last case is only one-twentieth of that in the first, the difference having appeared as heat in the conductor connecting the two condensers. We have, in fact, an efficiency of only five per cent.

Another condenser apparatus for reducing from a high to a low potential has been patented by W. J. McElroy. The groups of sheets of which the condenser is made are of two sizes, the smaller size being connected with the main line, while the larger are connected through the lamp-circuit with the earth. The main line is supplied by an alternating current. The inventor describes the result as follows: "The electro-motive force available for the consumption circuit is easily regulated or set by the relative sizes of the sheets in the respective sides of the condenser, — the larger the difference, the lower the induced electro-motive force, — and the number of sheets will depend on the current strength needed for the particular circuit supplied. . . . For example: if it be desired to carry on the main line a current of 1,000 volts, and to supply a current on the consumption lines of 100 volts, then the size of the sheets on the one side must bear the proper proportion to those at the other side."

If we consider for a moment what the potential of the sheets on the consumption side will be, we see, in the first place, that, if they are not connected in any way with the earth, their potential will be that of the high-potential plates. If they are directly connected with the earth, their potential will be always zero, and, according as they are connected to the earth through a high or low resistance, their potential will be high or low. As for the increased size of the sheets connected with the lamp-circuit, it has nothing at all to do with the phenomenon, and the effect would be approximately the same if they were reduced to the size of the small sheets. It would not be difficult to calculate whether the system would regulate itself, but it is hardly in place here. Some of the objections to it, outside of the question of regulation, lie in the size of the condensers required, and in the fact, that, if only a few lamps are in use, it would be almost as dangerous to touch the lamp-circuit as the dynamo-circuit.

THE ACTION OF ELECTRICITY ON THE VESICLES OF CONDENSED STEAM. — M. J. L. Soret describes the following interesting experiment in the *Archives des Sciences:* In a dark room a platinum cup containing water is placed on a metal support, which is connected with one pole of a Topler machine. Above this cup a metal point is placed, which is connected with the other pole of the machine. A Bunsen burner boils the water in the cup, which is powerfully illuminated by the projection of a large pencil of the electric light. As long as the Topler machine is at rest, the vapor vesicles ascend in the ordinary way; but, as soon as the machine is at work, the action of electricity on the vapor is manifested in a most striking manner. For a certain distance from the point to the surface of the water the clouds collect, and whirl along the edge of the cup; under the influence of the electric light, they look to a certain extent like flames. If the point is brought a little nearer the water, the vapor disappears completely, although the water continues to boil briskly.

COMMELIN, DESMAZURES, AND BAILHACHE STORAGE-BATTERY. — M. Reymer, in his recent work, 'L'accumulateur Vol-