stances resting thereon, and drive the products of the resulting combustion into and through the flames above the rear fireplace.

Health Officer Thompson of Chicago visited Des Moines to inspect the working of the garbage-crematory there, and in his report says, "The cost of the operation is much less than at the Montreal furnace. The device is simple, but it is as effective as any I know of. It does not need skilled labor, and does not use much coal. Two men seemed to be able to do the work there that ten did in Montreal. This furnace was built by Mr. James Callanan, a wealthy Des Moines citizen, to demonstrate what could be done in the way of disposing of garbage quickly and completely without offensive smell, and it is attracting attention all over the country. . . . I think myself that the Des Moines one is the best, and it is much the cheapest, and I am in favor of putting up our first one upon that plan." He further says there were thrown into the furnace while he watched it two dead horses, seven dogs, eighteen barrels of garbage, three hods of manure, fifteen bushels of rotten eggs, and three barrels of rotten fish. This was all consumed in one hour, with no offensive smell from the combustion, and no smoke. The furnace was cold when started.

The Des Moines *Leader* thus speaks of the Engle cremator: "The especial advantage of this apparatus is that it may be located in any part of the city without any offence. It is the invention of Andrew Engle of Baxter, Io., who also invented the process of destroying the filth of closets in houses by fire, which process, when once in general use, will avoid the necessity of polluting streams and lakes with deadly sewerage. A furnace built for this purpose has been in use in the old Capitol building at Des Moines for the past three years. It has given complete satisfaction, and demonstrated its adaptability for hotels, public buildings, and private residences."

The Engle Company erected one of their crematories, twenty feet long, in September of this year, at West Brighton, Coney Island, and had it in use until the close of the season, giving such satisfaction to the town authorities as to induce their hearty recommendation of its merits as being economical, scientific in principle, and cleanly and efficient in its methods of disposing of the refuse, and seemed to them the best means for the treatment of such nuisances.

One of these furnaces has just been erected at Milwaukee, Wis., and was put into operation during the recent meeting of the American Public Health Association in that city, and inspected by many of the members.

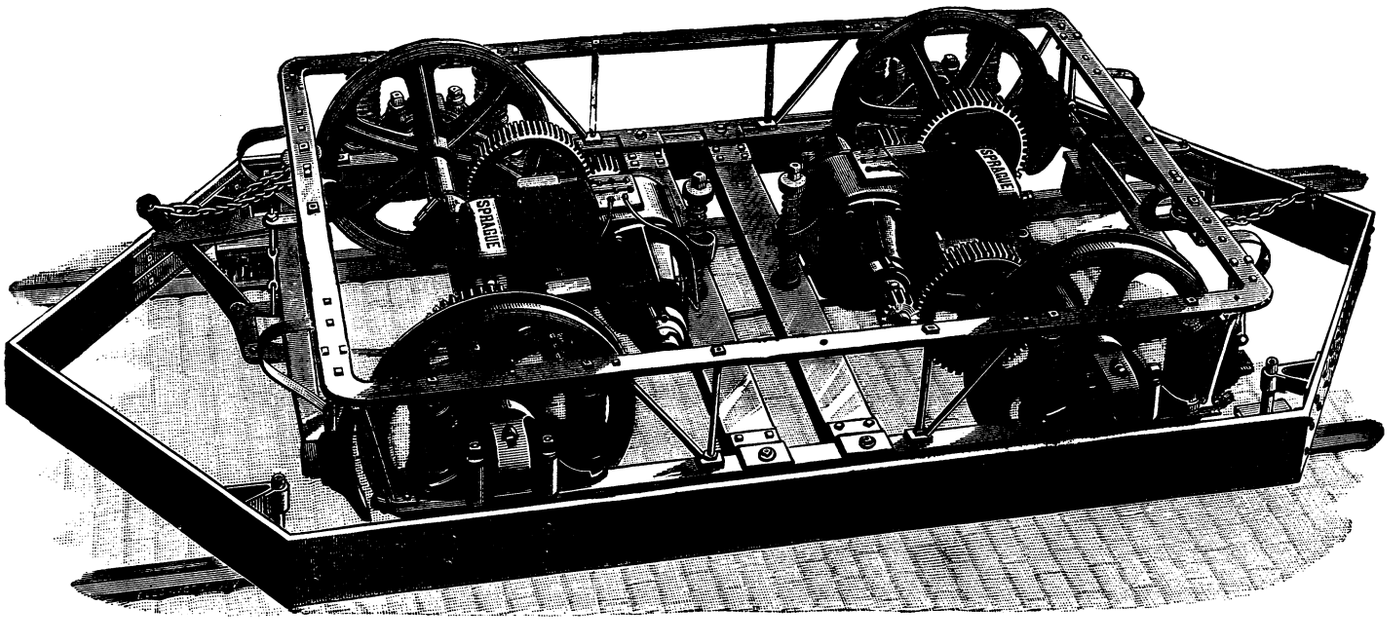
It is claimed for this furnace that it is not only applicable to large cities, but to almost every collection of human beings, even to a single family living in a private dwelling. The inventor says that its use is indicated in private dwellings in any locality in the country or city, but especially in all places where no system of waterworks is in operation, and also in villas and suburban places, where there may be a private water-system, but where drainage is into cesspools or small streams. The great majority of dwellings in the United States have neither water-closets, cesspools, nor drainage, and have none but the most cumbrous and inadequate method of coping with the great evil. The very low cost of the small furnaces brings it within the means of those who occupy the smallest class of houses, and its feasibility has been demonstrated for tenement-houses and for blocks of buildings in towns, as well as for detached houses.

For seaside or mountain resorts, where sanitary measures are more and more demanded by the public, this system affords the means of answering the demand, and will add to the popularity and desirability of such resorts by removing the great dread which city people have of typhoid and malarial poisoning. They can be placed in the basement or cellar, or in outhouses built for the purpose, wherever they can be connected with a chimney for draught and ventilation.

These furnaces are themselves the receptacle or vault, and no disinfectants or absorbents are needed, and no removal or handling. When fired, the valves are closed until the cremating process, lasting about an hour, is over. No skill beyond ordinary intelligence is required for the management of the fire or the apparatus.

For schoolhouses, large or small, it is believed this furnace will remove the greatest menace to the health of the children, and be a long step toward decency and comfort.

For factories or other establishments, and for military barracks; for railroad-stations, for camp-meeting or picnic grounds, and for all other collections of summer-houses; for county court-houses, jails, and other public institutions in city or country; for hospitals and prisons, — this system will be found to have advantages.




NEW SPRAGUE TRUCK FOR STREET-CARS.

## THE NEW SPRAGUE ELECTRIC-MOTOR TRUCK.

We take pleasure in presenting our readers with a view of the new electric-motor truck, constructed by the Sprague Electric Railway and Motor Company of New York. This truck is the same that was exhibited by the Sprague Company at the last street-railway convention at Washington, and one which attracted such wide attention and admiration there.

This truck is complete in every detail, and carries two powerful 15-horse power motors of a new design, and of the finest workmanship. Every detail of mechanical and electrical construction

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.

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## 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 fric-