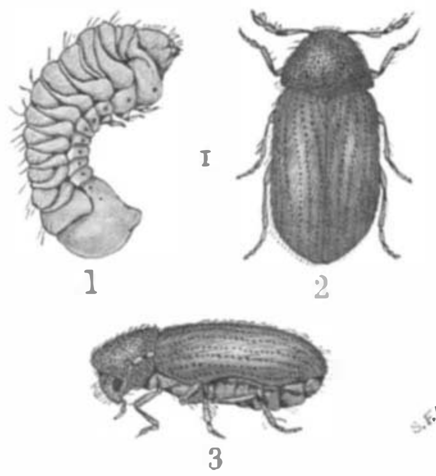
three cables were made and experimented with, before the final form was reached which approaches very nearly the conditions existing in a submarine cable. This was formed of thin strips of tin-foil laid on sheets of paraffined paper and carefully connected, their length being sufficient to afford considerable resistance, while the capacity was regulated by the thickness of the insulating material. The strips were then connected in sections, each being equivalent to one mile of cable with a resistance of 9 ohms and a capacity of ·074 microfarads, and were arranged in groups of fifty, one such group being contained in the heavy case shown in the center of the illustration, Fig. 9. Having a cable where there is resistance and capacity, it is possible to demonstrate experimentally the vigorous attenuation of the current and to study the propagation of the electrical waves. This attenuation, as has been said, is remedied by the insertion of inductance coils into the circuit, and the illustration and diagram show the method of adding such coils. The wires from the various sections of the cable are connected with brass plates placed on a long wooden strip and by means of plugs and binding posts the circuit can be regulated. At the gap between any two successive sections of the cable a coil or coils containing inductance can be added, and by merely inserting a plug can be cut out of the circuit. Using a small alternator, and circuits with suitable inductance and capacity, to impress a simple harmonic electromotive force the waves were investigated. The alternator was so constructed as to give currents of different frequencies and thus produce the circuit waves of different length. Then with a slide contact, *G*, and galvanometer, *H*, arranged as shown in Fig. 6, it was possible to assertain the condition of the current at any point along the line. In this way observations were made and curves plotted showing the maximum and minimum amount of current and the length of the wave passing along the conductor. Such a curve is shown in Fig. 7, the numbers along the horizontal line in the middle representing the distance from the middle point of the cable, and the dots the current at various distances from this point.



THE STORE-ROOM BEETLE.

1. Larva. 2. Beetle (dorsal view). 3. Beetle (side view).

Connecting these points we have a close approximation to an attenuated sine curve as required by the mathematical theory. In this case the wave length is 17 miles and the frequency 625 periods per second. Contrast this with the following illustration where the inductance is not properly placed in the circuit, and the result shows a remarkable attenuation and reflection of the waves. Leaving the exact mathematical considerations out of the question it may be stated if the induction coils are placed at intervals about one-sixteenth of the wave length the non-uniform conductor will be like a uniform conductor to within two-thirds of one per cent. If this is done the attenuation is made very small, comparatively speaking, and the electrical energy is transmitted with but slight dissipation. A numerical example will illustrate this more clearly. If the cable is employed with the inductance coils placed properly, then two and one-half per cent of the current generated at the transmitting end reaches the receiving end of the cable. But if the coils are cut out and the cable used in the ordinary way, then only one two hundred and fifty thousandth part of the current sent in at the transmitting end reaches the receiving end. In other words the insertion of the coils enables the cable to transmit 6,000 times as much current.

The first application of the results of this investigation has been to long-distance cable telephony. The cable being employed as before with the inductance coils at intervals of one mile, and at either end of the line two sets of ordinary telephonic instruments. Over this line of 250 miles of cable one can carry on a conversation distinctly, the fact seeming the more remarkable when it is realized that about 40 miles is the present limit for cable telephony and that the longest cables in the New York subways are 15 miles in length. These experiments from a purely scientific point of view demonstrate the feasibility of trans-Atlantic telephony.

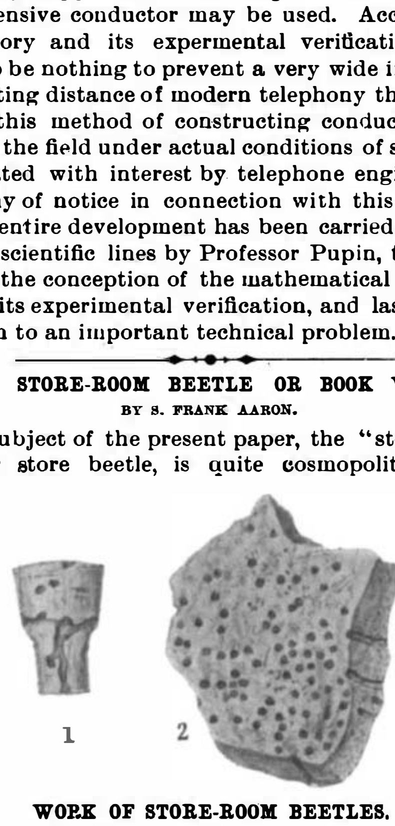
It is, however, in regard to its applicability to telegraphy, that its advantages for marine work must be especially considered, where, as soon as the speed is increased the attenuation of the waves occurs and a limit is very early set upon the rate of operation. With the attenuation taken care of by inductance coils added at specified distances along the cable, the current would be transmitted with small loss to its destination and not only would the ordinary speed of operation be increased, but by the use of methods similar to those employed on land for rapid telegraphy the efficiency would be made many times greater. The inductance coils could be added to the conductor at certain distances and placed within the sheathing at small expense in comparison with the cost of the cable, and being made about one inch in diameter and six inches in length would create no particular difficulty either in the manufacture or in the laying of the cable.

The earliest application of this method will doubtless be to aerial conductors to increase the present limits of long-distance telephony now placed at St. Louis from New York. The inductance coils at slight cost can be attached to the cross arms of the poles and instead of the heavy copper wires now required, a smaller and less expensive conductor may be used. According to the theory and its expermental verification, there seems to be nothing to prevent a very wide increase in the limiting distance of modern telephony through the use of this method of constructing conductors, and trials in the field under actual conditions of service are anticipated with interest by telephone engineers. It is worthy of notice in connection with this discovery that its entire development has been carried on along strictly scientific lines by Professor Pupin, to him being due the conception of the mathematical theory involved, its experimental verification, and lastly its application to an important technical problem.

THE STORE-ROOM BEETLE OR BOOK WORM.

BY S. FRANK AARON.

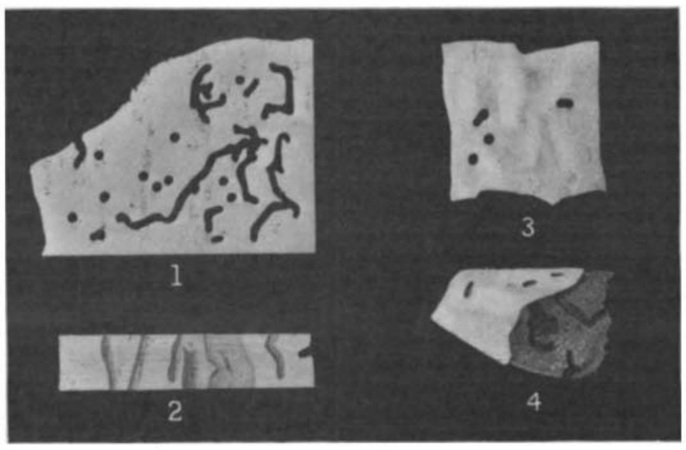
The subject of the present paper, the "store-room" or drug store beetle, is quite cosmopolitan, being found in the torrid as well as temperate regions of both hemispheres. It is by no means confined to drug stores, but has been given that name because it is frequently found in materials and products stored and sold by the druggist. While it attacks many animal substances, there is hardly any limit to the number of vegetable materials in which it works. Remarkable instances of its voracity and destructiveness are on record. The writer received from Japan ten bottles of silk worms that had been preserved in alcohol. The alcohol had evaporated from nine of the bottles, and the corks in each had been tunneled through and through and the silk worms turned to dust by these beetles. If the shrunken corks permitted the alcohol to evaporate, they would also allow the odor of the dried insects to reach the outside air, and thus the beetles were attracted.



1 2

WORK OF STORE-ROOM BEETLES.

1. Cork of bottle of destroyed silk worms. 2. Perforated oil cake.

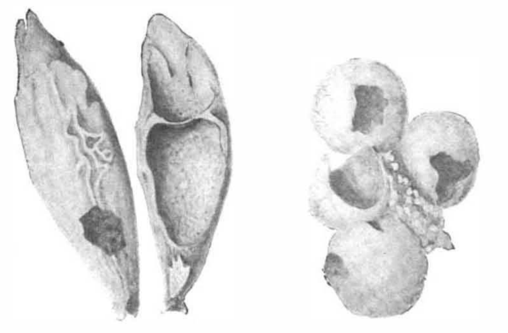


WORK OF STORE-ROOM BEETLES.

1. Paper bored by larvæ and beetles. 2. Section of book bored. 3. Tinfoil bored by beetles. 4. Pieces of chocolate covered by tinfoil, showing borings.

A still more amazing instance follows. Several pounds of chocolate were received, each cake wrapped tightly in tin-foil. In nearly every package the tin-foil had been extensively perforated by these beetles, the chocolate was riddled, and much of it pulverized. Of course the odor of the chocolate could not escape directly through the foil, but must find an outlet through its folds. It was noticed that but few beetles were found in the cakes in proportion to the number that must have wrought the damage, and that the edges of the holes in the tin-foil were turned outward more than inward, suggesting the idea that most of the beetles had entered between the folds and had emerged directly through the tin. True, the metal is exceedingly thin, yet it must present a serious obstacle to a tiny insect of not more than six or eight times its thickness.

A set of six books in paper binding was received from Brazil, including three different kinds and colors of paper. These were bored through and through, the covers, pages of text, and plates being alike attacked; in some places the beetles working edgewise or diagonally through the leaves and excavating good-sized holes. In all cases the print was entirely avoided, only the margins and the parts about the pasted or glued backs receiving the injury.



1 2

WORK OF STORE-ROOM BEETLE.

1. Barley grains entered and the interior eaten. 2. Sorghum seed bored into and destroyed.

Herbarium specimens of plants, seemingly without reference to species or condition, are subject to attack by these beetles. In such cases they not only perforate and eat away the dried plants, but also the paper upon which the plants are mounted. A sample is before me in which the one-time presence of the plant is indicated only by the dusty outline on the paper, which is bored through in many places. They are said also to attack manuscripts, drawings and gun-wadding.

No insect of the household or store room is as generally injurious as the drug store beetle. Such pests as the cockroach, the red ant, the rice weevil, and the woolen moth may be more in evidence, but their scope is far more limited and their ravages are more readily checked. The drug store beetle is the smallest of them all, but it makes up in its enormous numbers what it lacks in size. Its omniverous appetite is strikingly shown by another test. I recently reared several generations of these beetles in a small jar of ground pepper. They flourished there in the best of health, and they increased in numbers until finally the jar contained all beetles and scarcely a remnant of pepper dust.

To the scientist this beetle is known as Sitodrepa Panacea, a name given because the insect was first found in dried bread. It belongs to the family Ptinidæ. It is of a reddish brown color and varies in length from one-twentieth to one-tenth of an inch. The head is situated beneath the pro-thorax, the legs are slender, the body compact and rounded, and the motions rather slow. The larva is whitish yellow with black jaws, the pupa whitish, and the pupa case or cocoon is formed out of the dust of the larval borings. In an equable summer-like temperature the transformation lasts about eight or ten weeks, and in heated buildings there may be four or five broods annually.

The Current Supplement.

The current SUPPLEMENT, No. 1274, is an unusually interesting number. The leading article is devoted to the "Manufacture of Candles" and is accompanied by fifteen engravings. "The Murnau-Oberammergau Railroad" describes the new road leading to the scene of the Passion Play, and the play itself is also described. "The Art of the Paris Exposition and Some of its Buildings" is an elaborately illustrated article.

Contents.

(Illustrated articles are marked with an asterisk.)