PHYSICS

40,000 Volts on Autos

High Charges of Static Electricity Are Generated By Rubber Tires on Non-Conducting Road Surfaces

By JAMES STOKLEY

AS AMERICA'S defense program swings into high gear, more and more motor traffic flows along the roads from coast to coast.

Supplies to defense factories, army convoys, workers going to and from their job, tank trucks carrying oil to relieve the shortage along the eastern seaboard — these and many others are rolling along, continually subject to a very real and very insidious form of sabotage.

This is fire, set off by static electricity.

Any vehicle, which runs on rubber tires, accumulates charges of static electricity that may sometimes amount to as much as 40,000 volts!

Perhaps you have had the experience of feeling an electric shock when getting out of your car. Or you may have felt it when handing a coin to a toll collector, or when boarding a bus. And even more familiar is the spark you can draw from your finger tips in the winter time when you touch some grounded metal object.

Such experiences are not only annoying, they may actually be dangerous. Not long ago, for example, several deaths were reported of patients in a hospital where explosive vapors used in anesthesia had been set off by sparks from the surgeons as they scuffed around on rubber mats in the operating room. Charges generated on belting used in power drives in factories may have caused sparks which set off mysterious fires. And in discharging gasoline trucks, great pains must be taken to avoid any spark which might ignite the inflammable vapor.

Little Accurate Information

Despite the risk involved, it is surprising that, until a couple of years ago, there was little accurate information on the subject of static charges on automobiles. Since then, however, Prof. Robin Beach, head of the department of electrical engineering at the Polytechnic Institute of Brooklyn, has been conducting an extensive research on the cause and cure of automobile static.

Recently, in a report issued by the Society of Automotive Engineers, Prof. Beach explained how a car becomes electrified.

"The generation of electric charges at the areas of contact between the tires and the roadway has been attributed to the process commonly known as 'frictional electricity,' " says Prof. Beach. "This is both a misnomer and a misconception of principle. The basic principle underlying this phenomenon is actually that of 'contact difference of potential.'

"If one substance is pressed firmly into contact with another, electrons, which are the smallest known individual particles of electricity, are appropriated by one substance from the other. This action causes that substance into which these so-called 'free' electrons migrate to acquire negative electrification; and, because of the loss of electrons from the molecules of the other substance, it acquires an equal positive electrification.

Billionth of Inch Apart

"The so-called 'contacting' surfaces of the tires and the roadway are actually no closer than their molecular boundaries permit, and, therefore, they are separated, one from the other, by at least one billionth of an inch. As the two substances acquire their respective negative and positive electrification, they constitute a charged electrical condenser."

This difference of potential, he has found, is a fraction of a volt. But, "as the wheels roll along the roadway, each unit of area of the tire tread is, in turn, separating from the road surface.

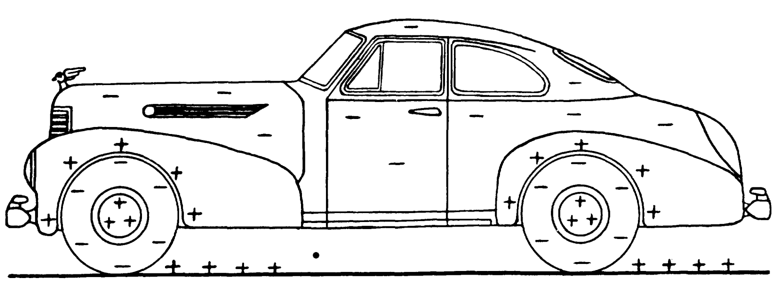
"This causes its condenser effect, or capacitance, to decrease to a very small value, and since the amount of charge on a unit area of the tire is a fixed value during a revolution of the wheel, the voltage between the roadway and the separating area of the tire greatly increases. A potential difference of thousands of volts may thereby be attained."

When the treads of the tire thus acquire a high charge of negative electricity, the free electrons in the fenders, wheel rims, and other neighboring parts of the car are repelled. In that way these parts, near the tire, get what is called a "bound" positive electrification, since they have less than their normal quota of electrons. The electrons, in their turn, migrate to parts of the car body as far as possible from the tires, and these parts have a negative charge. Then, if a wire is connected between these parts of the car body and some grounded object, say a hydrant, the electrons will flow away. The voltage between the car and the ground may be as high as 40,000 in the case of heavy trucks and buses, enough to make a spark that will jump a half-inch gap. It is small wonder that you feel a shock when you act as the connecting wire to a grounded person or object.

Drops Quickly

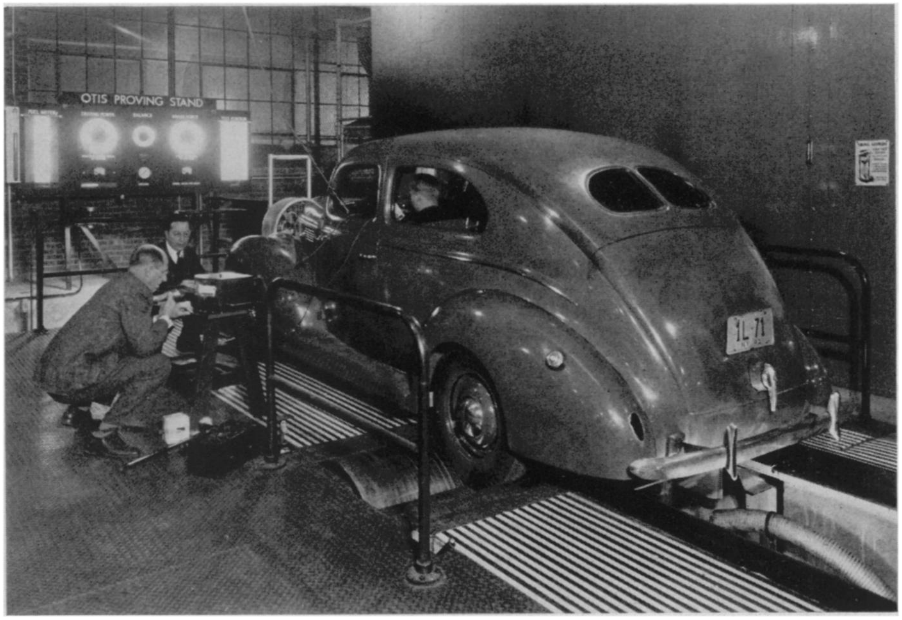
Prof. Beach has figured that, with a bus charged to 15,000 volts, the current flowing into a person's finger at the instant of contact is five amperes, though it would drop to zero in a thousandth of a second.

"The physiological effects of electric current through the body for such short durations are not known," he declares, "but currents of these magnitudes may



WHAT HAPPENS

Electric charges on an automobile as it drives along a modern highway are indicated in this diagram. The tires themselves receive a negative charge, and leave a trail of positive charges on the road after them. Parts of the car near the tires are positively charged as negative charges are repelled to more remote regions.



MEASURING CHARGE

Prof. Robin Beach (left) makes measurements of the static charge on an automobile as it is driven at speeds equivalent to as much as 70 miles per hour on the proving stand.

prove serious. Strong, hefty mechanics have been known to be thrown to the ground by shocks received from touching the bodies of electrified automotive vehicles."

In order to test these conclusions, Prof. Beach turned his own automobile into a mobile laboratory. He connected wires around it, and installed a meter that measured up to 30,000 volts. He took his instruments to the toll booths of the Holland Tunnel and the Marine Parkway Bridge in the New York area, measuring the voltage between vehicle bodies and the ground as they stopped. Then he made tests on a "proving stand." This permits a car to be operated up to "speeds" of 70 miles per hour, while standing still, running on rollers.

Speed Increases Charge

The faster the automobile is going, and the greater the "pull'" that it has to exert, the more charge it accumulates. This, of course, follows from the basic principle "that the more intimately the contacting substances are pressed together the greater the generation of static electricity."

One might suppose that when a tire is soft, there would be more contact with the road, and more electrification, but this is not the case. At low speeds there is little difference, but Prof. Beach's tests showed that, at 40 miles per hour, a charge of nearly 10,000 volts was obtained with 40 pounds pressure in the tires. Using similar conditions, but with 80 pounds tire pressure, it was more than 13,000 volts with the same speed. The reason is that, with more inflation, there is greater loading on the tire, and it is pressed into more intimate contact with the road, though over a smaller area.

Chain Doesn't Help

Dragging a chain after the vehicle, a common practice with oil trucks, made no measurable difference in aiding the decrease of voltage on the car, he found. "Since the pavement was not grounded but comprised a most excellent insulator, the drag chains, obviously, could not be expected to discharge the car," he points out. Measurements of the insulating properties of dry road surfaces were made with an instrument called a "megger" and showed the resistance to be extremely high, even between two metal strips a quarter of an inch apart. In some cases, the readings went beyond the scale of the indicator. When the road is wet, its conductivity is increased.

Even grounding the car, by connnecting it to a wire or grid, the practice used in various filling stations, is not entirely effective. While the free charge on the body can be removed in this way, the charge on the tires, and on the metal parts of the car near them, remains.

"If a wrench or screwdriver, for example, was inadvertently brushed against one of these parts, a spark might result of sufficient intensity to ignite lurking inflammable vapors," says Prof. Beach.

It has been suggested that the tires should be made conductive, by painting their walls, or even making them of a special kind of rubber which conducts electricity, but this is also ineffective. Even with metal tires, highly conductive, the situation would be fundamentally unchanged, he finds, for although the charges would then be distributed somewhat differently, there would still be the same voltage between the car and ground.

Probably the most effective remedy would be to make the surface of the roadways of some material which would carry away electricity. Then, with conducting tires, the charge would be dissipated. But it might be very difficult to change the character of the nation's roads so radically and there may be other solutions of the problem. Prof. Beach suggests that perhaps some method may be found of reducing the generation of the charge at the tire treads.

"This," he says, "would strike at the very heart of the problem."

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AERONAUTICS

"Lop-Sided" Airplane Convinced British Editor

A "LOPSIDED" airplane, with two engines, one in the nose, the other in one wing, and not balanced by a similar engine in the other wing, may not be as foolish as it seems at first glance, suggests C. M. Poulsen, editor of the British aviation weekly, *Flight* (July 3).

Writing in an editorial, he says that a letter from a reader of his magazine, who is serving in the R. A. F., suggesting such an arrangement, quickly landed in his waste basket. But then he retrieved it, and when he added to the rough sketch certain parts that had been omitted by its author, it "began to look less crazy."

"The advantages of the arrangement are obvious," he declares. "Instead of two engine nacelles and one fuselage, one has but one engine nacelle and one fuselage. Thus not only weight, but quite appreciable drag should be saved.

"Against the scheme," he admits, "is the fact that the machine might have to fly slightly 'crabber,' due to the fact that the drag of one engine installation would be greater than that of the other."

He asks for the views of designers and pilots on the matter.

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