lunar halo very nearly on the same circle of altitude as the moon and the crossing points were marked by exceptionally brilliant patches of auroral light. The outstanding feature of the phenomenon was the existence of horizontal streamers extending several degrees through the patches and diverted away from the moon as an apparent radiant point. These horizontal streamers with an apparent radiant at the center of the halo made angles of 20°–30° with the long auroral streamers but gave every appearance of a true auroral effect. The distance of one of the bright patches from the moon was observed with a sextant and found to be 25°, thus fixing the radius of the lunar halo. The large halo vanished at 11:50 P. M., whereupon a smaller ring of 4° radius appeared about the moon. This in turn vanished at midnight. At 12:10 A. M. the large 25° halo returned for about five minutes and at 12:20 A. M. a symmetrical cross with horizontal and vertical beams appeared across the moon's disk. Shortly after 1 A. M. a light cirrus stratus had developed and the aurora faded. The temperature was 30° F. There had been a fall of 33° F. since the day previous.

The combination of the optical effects in an all but invisible cirrus stratus with a true auroral glow gave a suggestion of the problem encountered in a study of the solar corona, where we may very well have light from electrical excitation mixed with an optical corona formed from minute particles comprising a circulating circumsolar cloud.

The effect of the auroral streamers at presumably an altitude of four or five hundred miles, combined with optical phenomena in a layer of cirrus at an altitude of four or five miles gives one food for thought.

On examining our sunspot photograms the following day a spot of marked intensity passed within 5° of the sun-earth line on midnight, Eastern Standard Time, March 28–29. The field strength of WBBM as measured on the automatic radio recorder 9–10 P. M., March 28, was exceptionally low and the static heavy.

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"WASHBOARD" OR "CORDUROY" EFFECT DUE TO THE TRAVEL OF AUTOMOBILES OVER DIRT AND GRAVELED ROADS

SEVERAL articles have appeared in SCIENCE[1] dealing with the subject of washboarding of highways and there are some confirmations and some new ideas I would like to present.

In regard to the washboards themselves, the term is in common use in the Pacific Northwest where practically every graveled road is inflicted with them. In the semiarid regions, during the drier seasons, these corrugations develop to considerable size and the maintenance of roads is a very difficult problem. No sooner is a newly graveled road opened to traffic than the washboards develop and there they stay, increasing in size until the grading crew removes them, temporarily.

It should be noted that it is the high-speed traffic that causes the washboarding. Horse-drawn vehicles do not develop these road-waves, nor do heavy trucks, which pound a road into many spring-breaking chuckholes. It is the pleasure car with its pneumatic tires and high rate of speed that appears to do the damage. Tires with new treads can throw loose pieces of road metal with considerable violence, in fact the writer was recently in a car which had its windshield broken by a passing car throwing a small pebble.

Loose gravel does not appear to develop washboarding until a portion of the surface has become hard enough to wave. This is of importance in road maintenance, for dirt binders are frequently added to pack the crushed rock, and thus automatically increase the liability of washboarding.

The writer was employed by the Washington State Highway for some time. Washboarding was an important maintenance problem, in fact one of the biggest. The opinion was reached that when the rear wheels of the car hit a small bump they begin vibrating. The resultant spin of the wheels while they are in the air digs out small depressions when they hit, and the corrugations grow in the line of travel with each succeeding car. On roads covered with loose gravel, an experienced driver can frequently find relief by driving a few inches to one side of the well-packed rut and thus escape part of the vicious, neck-breaking vibrations. However, he simply widens the washboarding and soon they extend across the road.

With this idea in mind, the following experiment was performed on a newly graded and graveled road between Yakima and Ellensburg, Washington, under the direction of Max L. Mook, District Engineer for the state highway department. The road grade had been allowed to settle for a year, then dragged and graded and treated with fine crushed basaltic rock to which a small amount of dirt binder had been added. The road was opened in perfect condition. The in-

[1] Dodd, L. E., "'Washboard' or 'Corduroy' Effect due to the Travel of Automobiles over Dirt Roads," SCIENCE, September 2, 1927, 214–16.

Ruckmick, Christian A., "'Washboard' or 'Corduroy' Effect due to the Travel of Automobiles over Dirt Roads," SCIENCE, November 18, 1927, 481–82.

spection party stationed themselves on either side of a fill with the level of their eyes at the road grade, and a three-fourths-inch rope was stretched across the grade. As the cars hit the rope, the rear wheels were set into vibrations which continued for some distance, and each time the wheels hit the road grade they were observed to throw small amounts of gravel. Within a short time a beautiful set of washboards extended away from the rope but on the approach side little or no corrugations were observed. It might be added that in two weeks' time the road was so badly washboarded that it was necessary to put on a grading crew to resurface the road.

In this semiarid country, the driver's chief object is to get over the road just as quickly as the uniformed motorcycle patrol will allow him. Washboards will develop. It is hoped that road oil, used to reduce the dust menace, will alleviate the damage somewhat. Even the widely praised black-top or bithulitic pavements washboard in hot weather. It appears that the solution is to be found in either leaving the car at home, or in paving with concrete.

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FOLLOWING the discussion and correspondence on the "Washboarding" or corduroy effect on roads traveled by automobiles by L. E. Dodd and Christian A. Ruckmick in the issues of September 2 and November 18, I have a version to contribute. Mr. Dodd's physics is beyond dispute, but my addition is to the road scraper theory. I have seen this sort of ripple on tar and macadam roads. Scrapers are not used on the surfaces of these, although they may be used in leveling the work before the hard surface is put on, and any initial roughness may be imparted up to the surface. Again, in leveling off the surface of macadam a straight edge board is often used, a man on each end pushing it along, but any waviness here would be very minute.

Last summer I was returning by motor from a trip into the Province of Quebec. All the crushed rock and gravel surface roads between the St. Lawrence River and the New England line are very "washboardy." Canada has some very good roads and some very poor ones, concrete and macadam in proportion to the size of the country with the United States, but in this eastern township's part of Quebec the main route north from New England is not yet all hard surface across the line, although roads are very good. You see a great many more horses belonging to the farmers, perhaps one Ford to each farm and a lot of auto tourist cars.

Having crossed back down into Vermont where the macadam began again, I was driving along, when there turned into the highway ahead of me a team of horses drawing a load of hay. It was a warm day, and as is the case when macadam becomes soft with the heat of the day, the heels of a man's shoe or the shoes on the horses sank into the tar slightly, leaving a small mark or hole. A team of horses, walking along a road as I could watch these walking, leave their hoof prints at regular spaces. As I drove along behind, before passing, I noticed how evenly, and, as near as I could judge by eye, this spacing was the same as the wave-lengths of the washboarding. After a team has gone along like this, the automobiles, coming along afterward, will pick up the little loose bits of tar dug up by the calks of the shoes, and by the friction, suction and so forth of the tire treads, hollow out the depression more and more.

The large number of these roads in Canada, as it may be in the West, corresponded, I thought, with the greater number of horses still there. I should say there were fifty per cent. more horses than in New England and New York, where farming is in many places on the decline.

The reason why the concrete roads do not washboard is because they have too hard a surface for the horses' iron to indent. Because, even though the concrete is so much harder, if there were any initial unsmoothness in the construction, either in using a scraper in the leveling of the bed above the subbase or in smoothing off the newly poured cement, in time, heavy automobile or truck tires would cause this effect. Often you do see a certain slight roughness in a concrete road (I mean aside from the cracking), which has come there by the hand smoothing of the men pushing the smoothing board over it, and a slight vibration results, but this never enlarges to the common washboard size.

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A NOTE ON OVARIAN SECRETION AND CANCER

IN an article published in the issue of SCIENCE, for December 16, 1927, I gave a short preliminary report of work done upon the effect of ovarian secretions on the incidence of mammary cancer in a stock of dilute brown mice. One of the primary objects of the paper was to report the successful feminization of castrated males, by means of ovarian transplants, to the extent that they developed, spontaneously, mammary tumors; a thing which thousands of unoperated male mice of this stock have not done.

In SCIENCE of January 27, 1928, Dr. Leo Loeb calls me to task for not quoting him exhaustively in my bibliography and lists two "extensive" reports of his which I did not mention, thus creating in his opinion,