figures may not be strictly accurate, yet I believe they show fairly the conditions which exist.

One of the essential differences between the ordinary interurban and the city lines is that the former bases its fare upon the number of miles the passenger is carried, and is thus able to proportion its charge to the service it gives, while the city line operates upon a fixed fare and hence is often forced to take business upon a losing basis. Furthermore, our city governments and our railroad commissions have as yet failed to give the interurbans the same strict supervision that they have to the city properties, and this has tended to make the interurbans more attractive. I believe we are justified in saying that we have probably reached the limit of economic development of our city lines on the present fixed rate of fare, and not only that but further, if existing taxes, prices and service are not to be reduced, there must be a readjustment of the fixed 5-cent fare and universal transfer in order to insure a fair return even on the present investment.

SOME REFRACTORY SUBSTITUTES FOR WOOD.

At the meeting of the American Society of Mechanical Engineers held in Boston, November 16, 1911, the Boston Society of Civil Engineers and the Boston section of the American Institute of Electrical Engineers coöperating, a paper was presented by Prof. Charles L. Norton, Mem. Am. Soc. M.E., of the Massachusetts Institute of Technology, on Some Refractory Substitutes for Wood. An abstract of the paper follows:

The common use of wood in and around our buildings is responsible for a considerable part of the annual fire loss, and the discovery or invention of a satisfactory substitute which would possess the desirable properties of wood and yet be non-combustible has been long hoped for. It is clear that in order to be accepted as a substitute for wood in building construction, a new material must approximate in lightness, strength, elasticity and ease of working, the natural woods, and further, since the variation in natural woods fits them for special details of construction, the substitute must be had in different grades of hardness, toughness, fineness of texture, etc. Moreover, the ease of working, sawing, boring, nailing and so on, leads to a wide use of natural wood, and a substitute to be acceptable must approximate the ordinary natural woods in these respects.

Many of the earlier attempts were made in the direction of altering the natural wood by some chemical treatment, so as to make it ignite with greater difficulty and burn more slowly and without much flame. These processes afforded a number of so-called fireproof woods. The principle underlying the chemical treatment was usually one of two. First, the wood was saturated with a solution which, on drying, left in the pores a salt capable of giving off a gas when heated, this gas being of such a nature as to be incapable of supporting combustion. Phosphate of ammonia and tungstate of soda were extensively used for this purpose. With thorough saturation the protection afforded the wood and adjoining portions of the structure was by no means insignificant; specimens of wood treated with phosphate of soda have been in the possession of the author for more than ten years, and after ten yearly tests show no signs of deterioration. Similarly some specimens of wood and cloth treated with tungstate of soda in 1903 have shown little or no loss in fire resistance. The main value of such chemical protection lies in its diminishing the volume of the resulting flames. When once thoroughly ignited, the fireproof wood burns more briskly than the natural untreated wood.

The second method of chemical treatment was one in which such substances as alum were used in order to supply a considerable quantity of steam from the water of crystallization and also to encase the pores of cells with a solid refractory substance.

A still earlier procedure was that of protecting wood from contact with a combustion-supporting atmosphere by coating it with thin sheet metal, usually tinned iron or copper. For doors and shutters this was found very effective. More recently hollow metallic members for doors and trim and for furniture have been extensively used, with a considerable degree of success. They are, of course, non-combustible, and under ordinary exposure keep their shape fairly well.

The wooden lath is without doubt responsible for the rapid spread of fire in many buildings of the older types of construction, and the attempts to develop a substitute have resulted in the metal lath and in the so-called plaster boards. The former are eminently satisfactory as substitutes for wooden lath, their greatest defect being their liability to become weakened by corrosion in damp places when used with certain kinds of plaster. The plaster boards are made of plaster of paris and some fibrous binding material, often wool, hair, or jute. Some are made of superposed layers of wool, felt and plaster. All, however, contain so large a percentage of plaster or other non-combustible material that combustion proceeds very slowly.

There have been from time to time, in the last 30 years, attempts to make use of boards composed only of refractory, inorganic substances. In general, such boards have been composed of some fibre and a cementing medium. The most popular fibres for this sort of experimentation have been asbestos and mineral wool, the cements used including about all the common cements of both the air drying and the hydraulic types. Oxychloride of magnesium, the value of which as a cement was discovered some 50 years ago by Sorel, has been the favorite cement for experimenters because of its simple preparation, its quick hardening and great strength. For some reason, however, a large percentage of the oxychloride cement is variable in its properties and often defective. When mixed with sand or similar dense bodies the oxychloride is often satisfactory for long periods, but the experience of the author with mixtures of this cement with fibres, both organic and inorganic, leads to the conclusion that it is unstable and unsatisfactory. This is more probably the case when the boards are used in damp places or out of doors.

There next appeared a number of wood substitutes in which a fibre was bonded by silicate of soda, commonly known as water-glass. Some were made in this country, but the most serious attempts were made in England and Russia, where the Imshenetzky process was used to make a board called uralite. It was the most satisfactory substitute for wood which had appeared up to that time. Uralite was composed of a sheet of asbestos millboard saturated with a solution of silicate of soda, which was subsequently precipitated as colloidal silica by a solution of bicarbonate of soda. For some reason not connected with the physical or chemical properties of the material, uralite has practically disappeared from the market. There have appeared from time to time a number of patents for boards composed mainly of fibres and lime, but no great use seems to have been made of them.

After much study two conclusions seemed inevitable to the author: First, no homogeneous inorganic substance was likely to prove satisfactory, but that a mixture of a fibre