

In short, the depreciation of the receiver parts in the induction system is represented by a practically irreducible minimum.

A similarly low depreciation must exist with regard to sundry parts of the engine equipment, such as the relays, and to a less degree the speed-control mechanism; and as to the other parts they are of the order common to standard air-brake equipment.

The costs of wayside equipment depend upon many factors, such as the existence, or otherwise, of poles and common circuits, whether the poles are owned or leased, whether a DC or an AC signal system, or none, is used, and the kind or capacity of batteries in the former, the presence or absence of AC power lines, and so on.

The requirements as to wayside pole circuits, with the usual common return and clearing lines, are the equivalent of one conductor per signal indication, roughly per mile of double track, and the fundamentals of our track magnet circuits are elemental in character. Their application to existing circuits is a matter of ready adaptation by signal engineers, and one affording no excuse for complication or material expense.

The power used in the circuits of the track magnets for clearing them, when installed on the normal danger system, is inappreciable, for, except in a special case, current is used only when a train is passing through a block and the advance block is clear. It is a function of the number of locomotives in use, regardless of the length of the division, and according to present experience would average a kilowatt rate for from fifty to seventy-five locomotives in service, divided among all the batteries on the line—less than is required to light a single passenger car.

While the system described has been developed under my direction it would be a mistake to assume that it is the product of any single mind, for it represents an accumulation of invention and experimental work in which my various associates have played a large part, notably our Chief Engineer, Lt. F. D. Sprague. I might add that we are also deeply indebted to the criticisms and suggestions of signal and brake experts, the natural result of many intimate contacts with them.

Elementary Proof of the Form of the Caustic by Reflexion.

G. CESÀRO. (*Bulletin, Section of Sciences*, Royal Academy of Belgium, No. 7, 1921.)—The caustic, "the cow's foot in the milk," is that cusped bright line found somewhat in front of a mirror of cir-

cular, not parabolic cross-section, when a beam of sunlight, parallel to a radius, is incident upon the reflecting surface. Two adjacent rays of the beam give rise to two reflected rays, which intersect at some point that is unusually bright because it gets energy from more than one ray. Let a beam of sunlight travel along the axis of a cylindrical napkin ring or of a tumbler, then tilt the object a little and the caustic becomes visible on the bottom of the tumbler or on a piece of paper across the end of the ring.

The form of the caustic has long been known, but for its derivation and investigation the differential calculus has been employed. Now Cesàro furnishes a derivation with nothing but algebra, geometry and elementary trigonometry, and all so simply explained that a good high school graduate can follow him. Would that the author might turn his talents to the elucidation of the Theory of Relativity!

With consummate art, for the article is "of a lucidity," as the French would say, we are led by easy steps to recognize that the caustic is an epicycloid. About the centre of the reflecting surface describe a circle with half the radius of the surface. Upon the radius of the reflecting surface, parallel to the beam of light and between this surface and the smaller circle just drawn, put a circle with a radius of one-quarter of the radius of the surface. This smallest circle is tangent to the surface and to the circle just drawn. This just mentioned point of tangency is a point of the caustic and is at the cusp. Now roll the little circle upon the inner circle. The point of the moving circle which was at first in contact with the inner circle describes the epicycloidal caustic as it moves away from its former contact, whether up or down.

G. F. S.

Isopropyl Alcohol.—The manufacture, properties, pharmacology, and uses of isopropyl alcohol are described by DUDLEY H. GRANT and CARL O. JOHNS (*Am. J. Pharmacy*, 1922, x-c iv, 418-425). This alcohol is a by-product of the petroleum and natural gas industry. The olefine gases, including propylene, are absorbed in sulphuric acid; and the resulting alkyl sulphuric acids are hydrolyzed with the production of alcohols. Propylene yields isopropyl sulphuric acid; and this compound is converted into isopropyl alcohol by hydrolysis. Isopropyl alcohol is readily dehydrated by a short digestion with an excess of dry sodium hydroxide, and subsequent distillation. It is more toxic than ethyl alcohol, but far less toxic than methyl alcohol. Isopropyl alcohol may be used as a dehydrating agent, an antiseptic, an antidote for phenol burns, a sterilizing medium for ligatures and instruments, a preservative for anatomical and pathological specimens, a key denaturant for industrial alcohol, a solvent in the manufacture of five chemicals, synthetic drugs, plant principles and related substances, a precipitant, and for other purposes.

J. S. H.