The Passing of the Steam Locomotive
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Railroad Electrifications of Marked Importance

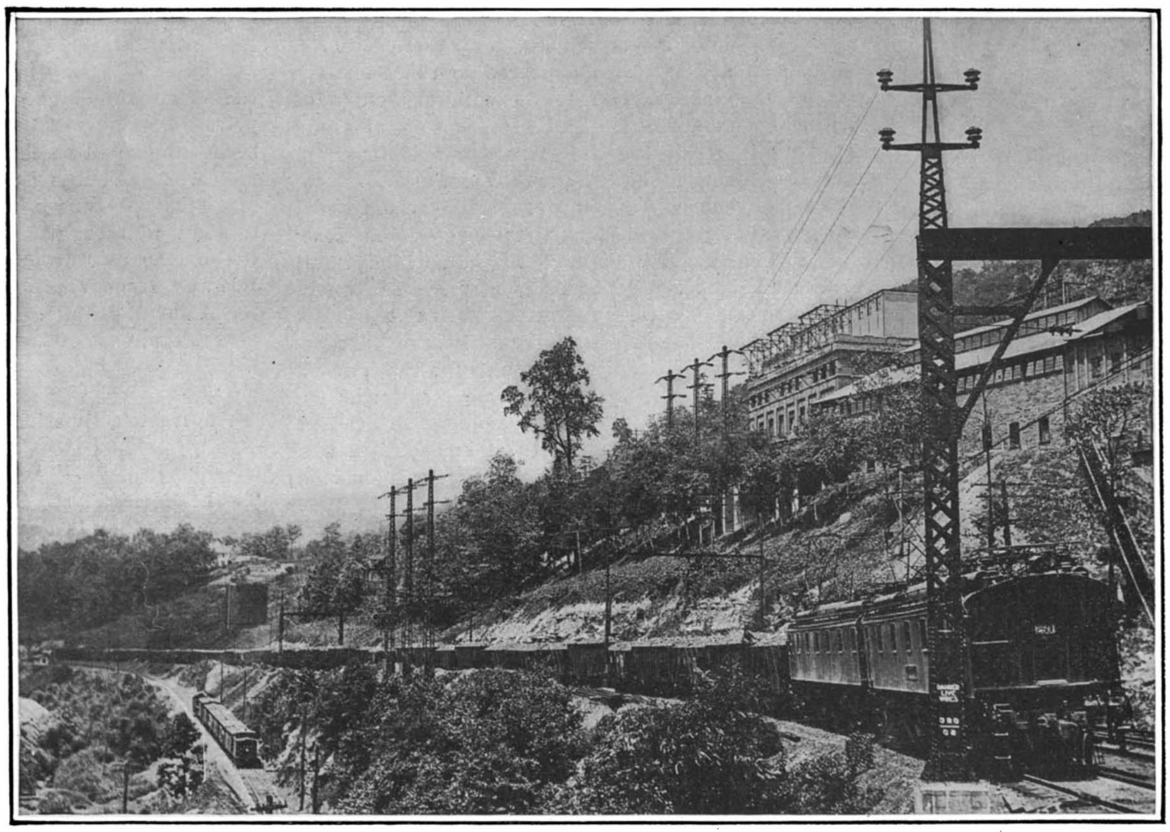
By Charles B. Brewer

As noted recently in the SCIENTIFIC AMERICAN the Pennsylvania Railroad, in September, inaugurated an electric train service over that part of its "main line" between Philadelphia and Paoli, on a stretch of its four-track road carrying fast through trains between the East and the West and hauling almost the heaviest traffic of any railroad in the world.

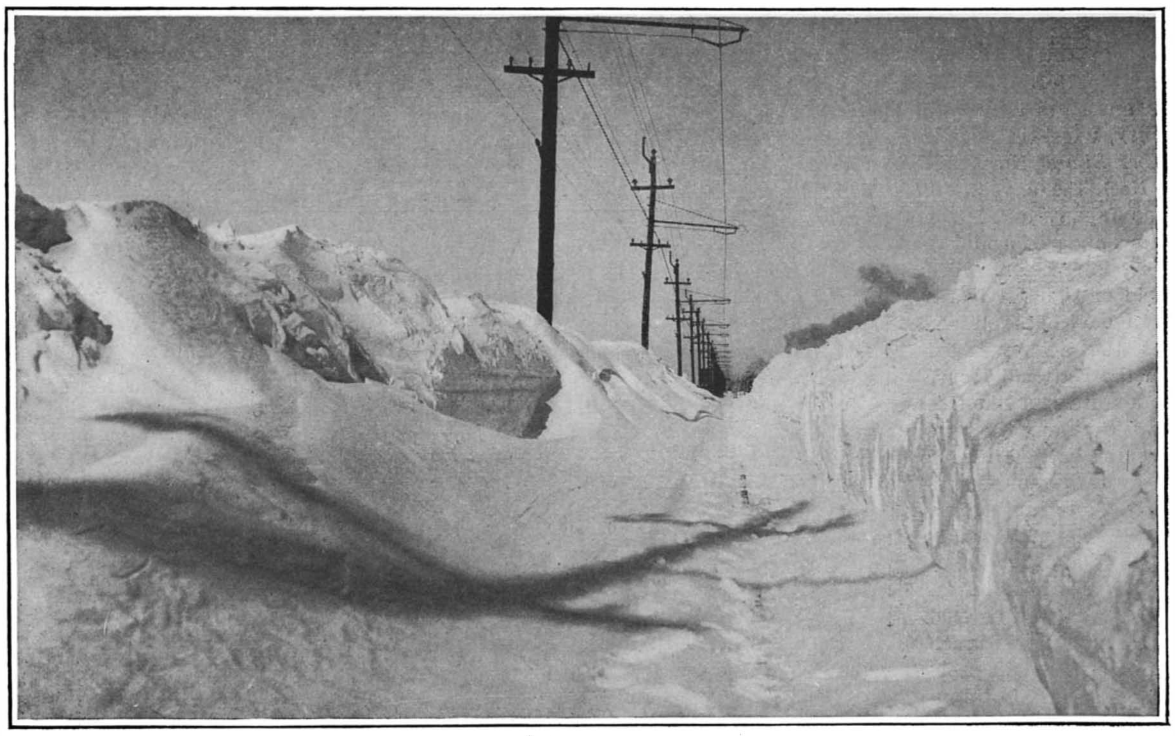
Another recent and even more significant instance of a great railroad, operating in close proximity to the coal fields, abandoning a part of its coal-burning equipment in favor of electric traction is that of the Norfolk and Western Railway on a division between Bluefield, W. Va., and the coal mines.

Heretofore special conditions have dictated the substitution of electric for steam locomotives, such, for example, as in the case of the Baltimore and Ohio Railroad, the first main line railway, by the way, to adopt the electric locomotive. There the problem was to avoid the smoke and gas in its Baltimore tunnel. The Hoosac Tunnel in Massachusetts, the Pennsylvania's approach to New York city under the Hudson, and the Great Northern's tunnel under the Cascade Mountains were doubtless dictated by similar reasons. The New York Central and the New York, New Haven and Hartford Railways were forced to electrification by legislative action, as a result of a serious collision in the tunnel leading into Grand Central Station, New York city. Other notable examples of electrification are at the St. Clair and Detroit Rivers, for railroads between the United States and Canada. Both installations are in tunnels. Typical examples of electric installation to secure the advantages of frequent service and short trains for suburban and interurban traffic are the Pennsylvania's West Jersey Road between Atlantic City and Philadelphia and the lines of the Long Island Railroad.

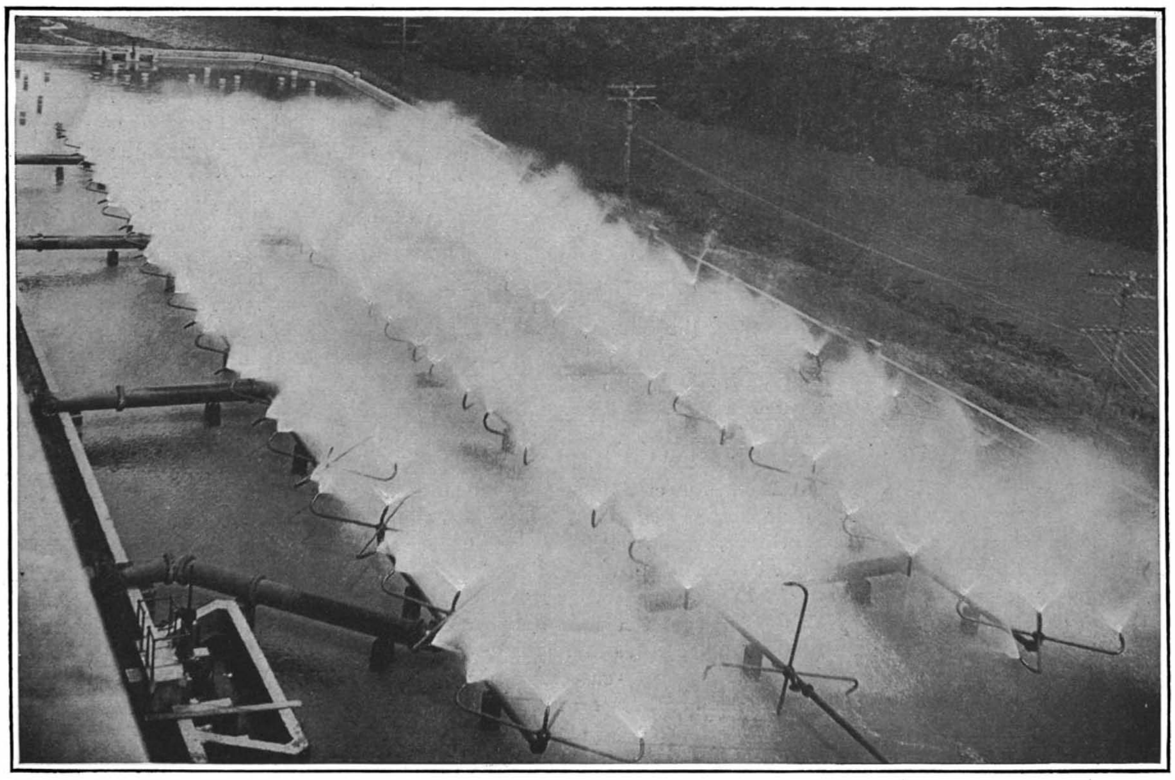
The reasons for adopting electrification on the Pennsylvania's "main-line" and on the Norfolk and Western Railway were, however, influenced by problems which constantly confront the railway officials of almost every system. Here we see, in one case, the steam locomotive supplanted dangerously near the heart of the Pennsylvania coal fields, and in the other case, at the very mouth of the West Virginia mines. No question of the utilization of water power entered into consideration in either case. Both receive power from boiler installations.



Electric locomotives on the N. & W. R. R. hauling heavier trains at twice the speed formerly obtained from steam locomotives



Snowdrift on the Des Moines and Southern 1200-volt direct-current line



Spray cooling pond for condensing plant, Norfolk & Western electrification

Might it not be well to ask: Who shall be bold enough to prophesy how long the roar and puff of the steam locomotive will be heard? And, especially, how long will they be heard in the great West, where coal is hauled hundreds of miles to mock the great water-powers along which it steams?

Steep grades and a heavy freight traffic dictated the change on the Norfolk and Western road. Because, under steam operation only 7½ miles per hour could be made by its freight trains with two locomotives and a "pusher," steam has given way to electricity. The new electric engines haul heavier loads at twice the speed over the steepest grades and nearly four times the speed over other parts of the run.

Yet many of the grades in the West are almost twice as heavy as those where this electrical installation has been called in to solve the problem of heavy grades. Two engines are used every day on grades on many Western roads for short passenger trains. The writer was recently a passenger on a train in the West where three locomotives were required for 14 cars, and saw a photograph of the Denver and Rio Grande Railway using five locomotives for 11 passenger and mail coaches. One of the principal divisions of this road parallels the beautiful Gunnison River for over 100 miles, in which distance there is a drop of nearly 4,000 feet. And the volume of water in this river is so great that the Government in an irrigation project, diverted a part of it to feed another river by tunnelling 6 miles under the mountains.

Electrification requires large sums of money. The Government's conservation policy, too, has been blamed for the slow development of water power in the West, and Secretary Lane in strongly advocating the Ferris Bill, states that development will not take place until a law is passed which will give such promise of safety to the investor as a reasonable man may ask.

The Electrification of the Norfolk and Western Railway

The steam locomotive which has been supplanted on the Norfolk and Western Railway is the famous "Mallet" compound type with mechanical stokers and superheaters; the last word of the locomotive builder.

The new Baldwin-Westinghouse electric tractors are the most powerful locomotives in the world. They weigh 270 tons and have a guaranteed horse-power of 6,700. Experience with them has shown a continuous output of 8,000 horse-power, and, while the trains are being accelerated the motors develop as high as 11,000 horse-power. The fact that the heavy express trains of the New York, New Haven and Hartford are hauled by 100-ton locomotives, which, when running 60 miles an hour develop only 1,500 horse-power, illustrates the tremendous advance in the power of the Norfolk and Western electric tractors.

One of the unique features of the Norfolk and Western installation is the use of the three-phase motors from a single overhead wire. By using the three-phase motor the locomotive can hold or brake the trains at constant speed while descending the grades, and utilize the energy by returning it to the line and making it available for any other train on the road. This is the first installation of the kind except on the line at Giovi, Italy. At Giovi, however, the trains are only 400 tons and on the Norfolk and Western they are 3,250 to 4,700 tons. Italy has been very quick to adopt advanced practice in electrification. An Italian railroad first followed the lead of the Baltimore and Ohio Railroad in the use of electric locomotives in 1895.

The advantages gained by the Norfolk and Western's electrification have been pronounced. Formerly two "Mallets," with a pusher at the grades, handled the trains at 7½ miles an hour and required *four* hours for the trip. One electric tractor, which also uses a pusher at the grades, now handles much heavier trains at 14 and 28 miles an hour and makes the trip in less than *two* hours. So far the electric tractors have handled 75 loaded cars with ease. It is the intention to increase the number until the limit is reached. An enormous draw-bar pull of 180,000 pounds has been recorded.

Electrifying a Stretch of the World's Busiest Tracks

Peculiar interest attends the work completed by the Pennsylvania Railway, which will give it the most modern and efficient 20 miles of electrified railroad in the world.

The work has cost about $4,000,000—a sum sufficient to buy a right-of-way and build 400 miles of ordinary track.

Every step has been taken with the care and precaution characteristic of the railroad which recently operated 68,444 passenger trains in a single month, and brought in 91 per cent of them on time, and during 1914 hauled over 180,000,000 passengers and lost the life of no single one of them.

While there will be a slight money saving to the company and while the public will receive a faster, pleasanter, and more frequent train service, the primary object of the change was to increase the traffic handling arrangements of Broad Street Station, Philadelphia. This station is known as a "stub" terminal. Every one of the 506 trains which daily arrive and depart from it can not leave until a fresh engine, headed in the proper direction, backs in from the yard to what was previously the rear of the train. After the train departs the first engine must back out to the yard and be reversed on a turntable. If any change is to be made in the train a switch engine must back in, haul the train out, break it up, remake it and back it in to the station. From four to eight such movements of trains and engines are necessary for every train arriving and departing. To reverse an electric car, or an entire electric train, the motorman simply walks from one end to the other. The greatly lessened time which the train occupies space in this crowded station will also be of no small importance.

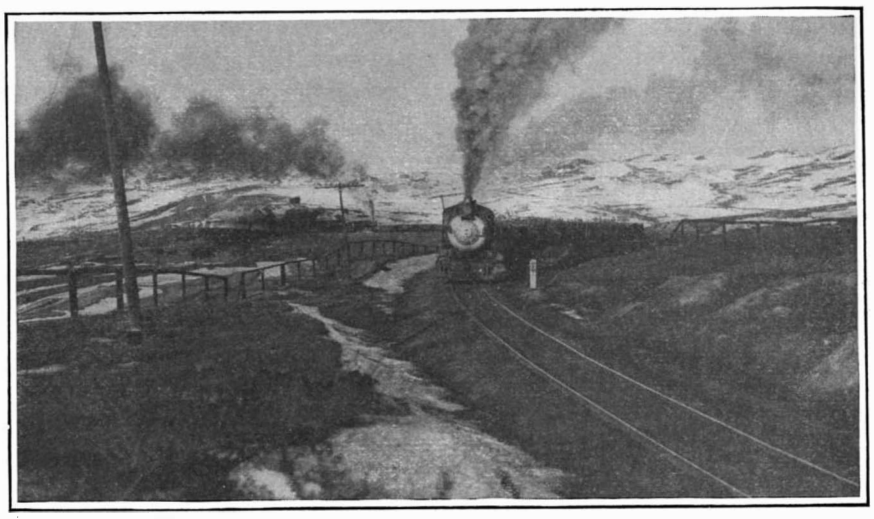
There are 19 stops in the distance of 20 miles, and a local train running with steam power, even though hauled by the heaviest of steam locomotives, is practically starting or stopping throughout the entire run. With electrification of the type adopted, each car has its own motor and a long train gains speed as fast as a single car.

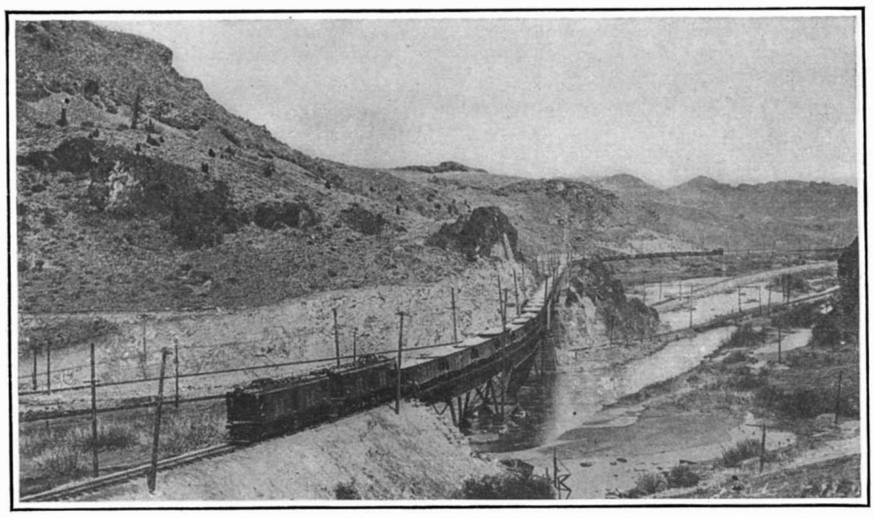
Experience of Various Railroads

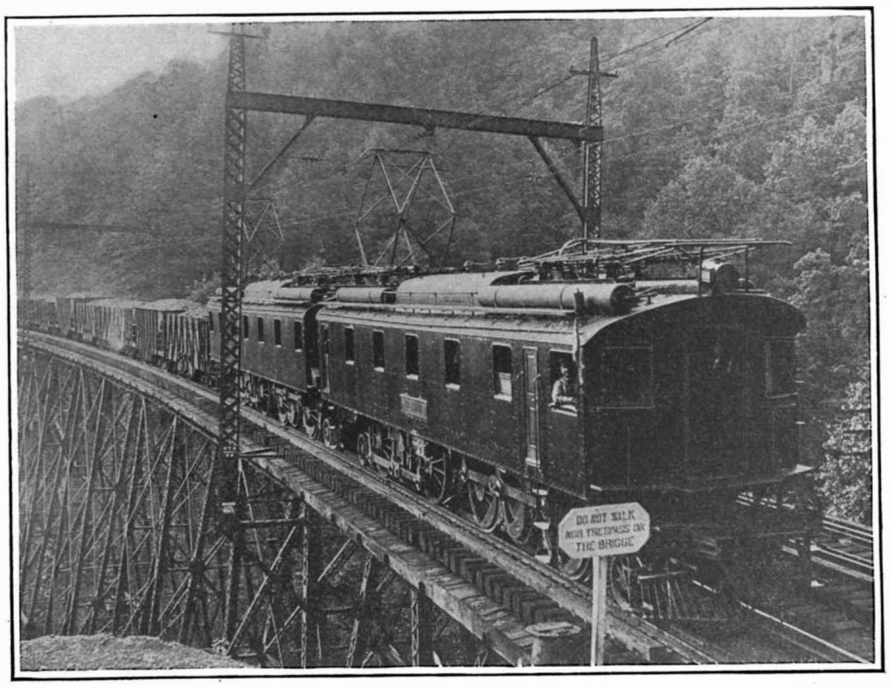
The Michigan Central Railroad installation at the Detroit River tunnel, connecting its tracks in the United States with those in Canada, has saved much time, prevented many delays, and avoided troublesome fog and ice conditions formerly encountered with its ferry service. Under the old conditions each ferry boat required 30 minutes to load, unload and make the crossing. The average capacity of each boat was 18 freight cars, so that three, and often four, ferry boats were required for many of the trains. Under the new conditions a train of any practical length and weight can be handled through the tunnel in less than six minutes.

An official of the New York, New Haven and Hartford Railroad has stated that that road's experience shows the upkeep cost of its electric engines per 100 tons of weight is five to seven cents per mile against 8 to 25 cents for the steam locomotive, dependent on kind of coal and water used. He also stated that a pound of coal under the boilers at the central electric station develops twice the draw-bar pull as if burned in the fire box of a steam locomotive.

Careful records by the Pennsylvania Railroad for four years show that 33 electric locomotives used during that time at the New York terminal, have totaled 3,974,746 miles. A number of individual engines have run from 90,000 to 112,000 miles before any general repairs were necessary, and the total train detention due to engine failures has amounted to but 4½ hours during the four years time.


Courtesy of General Electric Co.
View on the Butte, Anaconda & Pacific Railway before electrification


Train of copper ore, 65 cars, 4550 tons, on the Butte, Anaconda & Pacific Railway



Electric locomotives of 3-phase type which use a single wire

The Butte, Anaconda and Pacific Railway handles much heavier trains electrically than those formerly hauled by steam. The speed is also nearly twice as great. The freight movement is one of the heaviest in the world; yet owing to the increased train weight and schedule speed, night work has been greatly reduced, and at the same time, a larger tonnage hauled than ever before. The current is purchased, and added to the other advantages, about $200,000 per annum is saved in the cost of the current compared with the former coal bills.

The Chicago, Milwaukee and St. Paul Railway now has about 85 miles of its road electrified. Work is under way to electrify 440 miles additional. Trains will be heated by steam from oil-burning boilers. The saving on coal bills is expected to amount to over $1,000,000 a year.

Electricity is extensively employed in other countries. In Switzerland, where there is no coal and many water powers have been developed, it is used on many lines, and the Government, last year decided to so operate all the lines of the Swiss State railways. Three important projects are under consideration in India and work has very recently been completed in Sweden on 70 miles of the most northerly railroad in the world, between Kjeronavare and Narvik, which extends 130 miles within the Arctic Circle. This railroad has reported an increase of 40 per cent in the weight of its trains and a 50 per cent increase in speed by the use of electricity. When the power plants at Daleff and Porjas in Lapland are completed they will supply the power to the State railways of Northern Sweden.

The latest system of electrification will be used to operate the trains through the new Canadian Pacific tunnel near Glacier, B. C. This tunnel will be the longest railroad tunnel on the Western Hemisphere, except one for the unfinished "Moffat" road in Colorado. It is just 5 feet over 5 miles long. It cuts down the grade over 500 feet, shortens the route 4½ miles and eliminates 4 miles of snow-sheds which cost about $100,000 a year for maintenance. The engineering work of the undertaking forms a most interesting story of itself.

A work of great importance is also under way at Melbourne, Australia. The change affects 289 miles of track and involves an expenditure of over $10,000,000. Though provision is made for handling upwards of twice the number of passengers and also increasing the speed of the trains, the change will affect a saving of about $500,000 a year in operating costs. Originally 1917 was set for the completion of the work, but the General Electric Company, which is supplying 400 motors for the service, states it is so advanced that it will be in operation next year.

The eyes of the railway world are centered on these recent installations, and as this is written, arrangements are being completed for a special tour of inspection over the Norfolk and Western by ninety of the leading railroad officials of the country. Those looking for momentous signs in these stirring times will do well to closely watch the effect of these recent electrifications.

Preserving Milk Powder

A METHOD has lately appeared in Europe for preserving various food or other products, and especially milk powder, the idea being based upon placing the substance in a sealed vessel or packing case with inert gas, so that this latter prevents the usual spoiling of contents by the action of the air. In the French patented process, the milk powder is packed in metal boxes of convenient size which are entirely sealed except for a pinhole that is left at the top. A number of such boxes is put in a chamber and the air is exhausted by means of an air pump. When this operation is finished, valves are opened which allow nitrogen to enter the chamber and fill up the several boxes. Then opening up the chamber, the boxes are quickly removed and the pinhole soldered before an appreciable amount of air has time to enter. In this way the contents of the boxes are kept in an atmosphere of inert gas, and the process is most practical from an industrial standpoint.