15 (indicating the drops) in order to accustom the patient to the anæsthetic. After a few seconds, the operator raises the figure to 25 or 30 drops if the patient is a woman, and to 40 to 50 if a man. This quantity is maintained for four or five minutes. After the patient falls asleep, the quantity is diminished to 20 to 15 drops in order to keep up the anæsthetization, which is always excellent and calm.

## ELECTRICITY ON THE MIAMI AND ERIE CANAL.

The general interest which has been aroused by the appropriation on the part of the New York legislature of $101,000,000 for the improvement of the State canals, and also by the various attempts which have been made within recent years to use electric power in drawing the barges of the Erie Canal, lead us to suppose that an account of the Miami and Erie Canal, the only waterway in this country which is successfully operated by electricity, and the only example in this country of three-phase traction, will not be without interest to our readers. The work of electrifying the Miami and Erie Canal is due largely to the energy of Thomas N. Foredyce, who, in 1900, conducted a series of experiments with an electric towing locomotive which ran along the banks of the canal on a specially built track. Through the courtesy of Charles W. Ricker, an engineer, who rendered valuable assistance in the electrification of the canal, we are enabled to present illustrations of the waterway, and likewise to present a full account of the installation.

Active work was begun on the Cincinnati-Dayton section, 68 miles long, in July, 1901. The section is nearly completed, and the stretch from Cincinnati to Middletown, some 42 miles in length, is now in operation. The table in the footnote gives the length and depth of the canal.*

Along the line of the canal are 95 locks, each 90 feet long and 15 feet wide. The gates are of the wood, swinging-miter type, and are operated by hand. There is but one summit level, which is 395 feet above Lake Erie and 512 feet above the Ohio River. Its length is 23 miles, beginning 100 miles north of Cincinnati. The high levels are supplied by three artificial lakes and by rivers.

The canal boats are towed in a string by a locomotive running on the tow path. Before electric locomotives were used, each boat required, for twenty-four hours' operation, a crew of two steersmen, two drivers, and one cook—in all five persons—besides five mules. The average speed was about two miles an hour. With the new system, each boat needs only two men and the locomotive four men for the same period of time. The speed has been increased to three miles per hour. The numerous curves and irregularities of the channel render it impossible to string together more than ten boats, each 80 feet long. About 200 feet of line are used between the motor and the first boat, and 50 feet between boats, so that an electric mule drags a tail some 1,500 feet in length.

Since the whole length of the canal is to be supplied from a moderate number of generating stations, the principal transmission is naturally by alternating current at high tension, with reducing sub-stations at intervals along the line. Owing to the small number of large units forming the load, and their ability to bunch, the sub-stations must be placed far apart, or some of them will be idle much of the time, thereby involving a low all-day efficiency. The average demand per unit is high, involving a high average line loss. These conditions rendered it necessary to select a high trolley voltage. The running conditions are such that induction motors can be used to advantage. Stops are infrequent. A string of boats must be set in motion slowly in order to prevent breaking of the towing lines. Hence the slow starting torque, as compared with series motors, is not a serious objection. The higher trolley voltage possible assures good regulation and a good starting torque without excessive expense for copper.

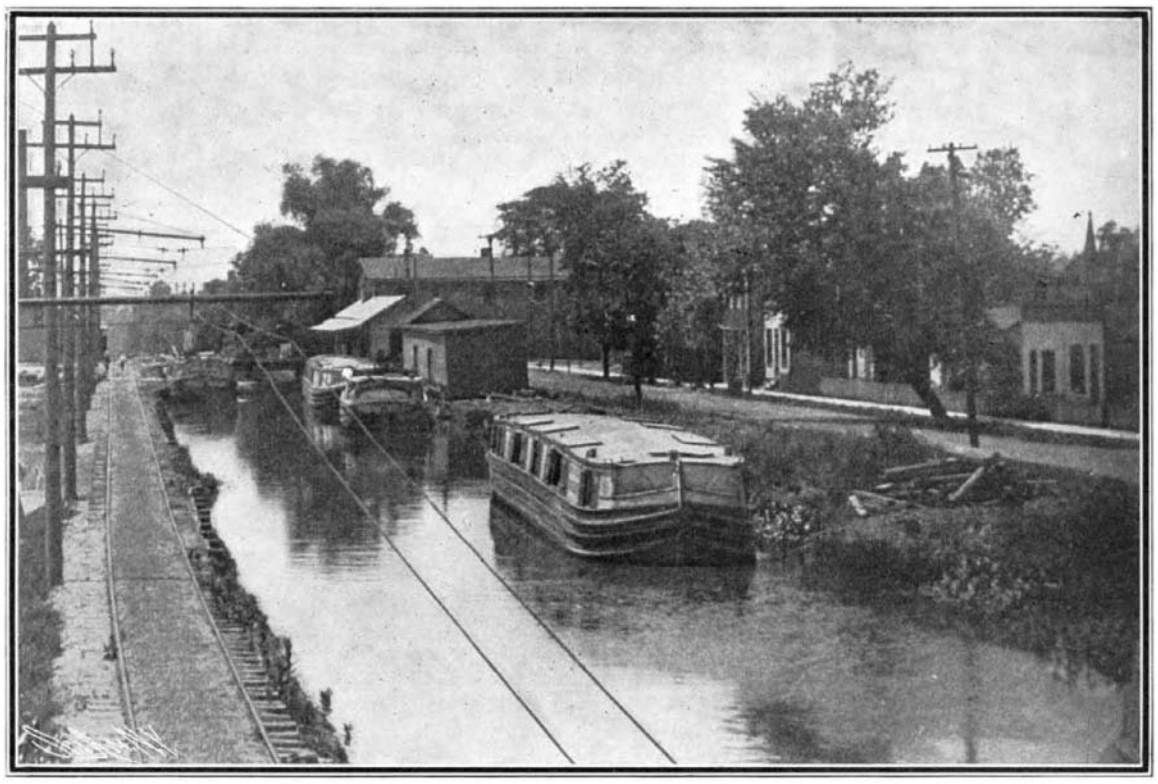
The Cleveland Construction Company, who designed the electrical equipment, installed an alternating-current system throughout, with locomotives equipped with three-phase induction motors to which energy is supplied from a three-conductor line, consisting of two overhead trolley wires and the track.

The track is built along the towpath with the finished surface 2 feet above the water level. Between Cincinnati and Hamilton, the canal lies mostly along hillsides, with the towpath on the higher bank, which is about 16 feet thick at the water line, with slopes of 1¾ to 1. The sub-grade is 12 feet wide. The central line of the track is about 6 feet from the water's edge.

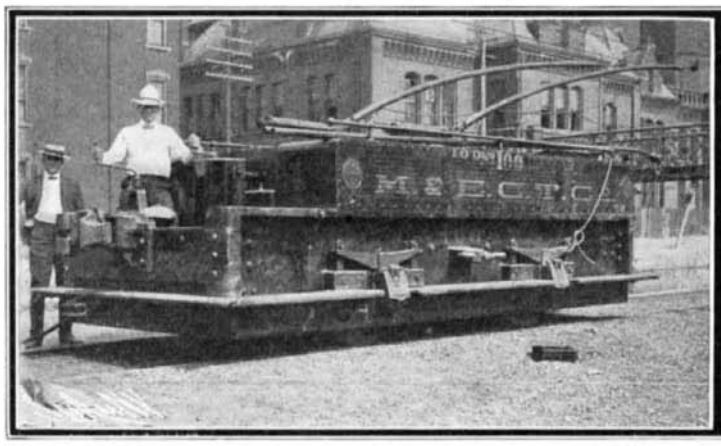
Along the main line, the maximum curvature is 25 degrees. In Cincinnati, however, there are sharp curves which require a very short wheel base for the locomotives. The only grades are at locks and depressions under low bridges. The steepest slope is 2 per cent. Within the city limits, railroad bridges and street bridges could not be raised, so that the tracks under them had to be depressed to allow the locomotives to pass. At three places the towing track crosses the canal. Where a drawbridge has been installed it must be opened immediately after the motor has passed to allow the boats to float through. Quickness of movement is important.

A three-phase, 60-cycle current at 4,200 volts is delivered at the switchboard and transmitted over the transportation company's lines, 5 miles distance to the first station—just within the northerly limit of Cincinnati. This is a motor-driven generating station which supplies the first trolley section, extending from the Cincinnati terminal northerly 7½ miles, at 390 volts, 3-phase, 25 cycles. Static transformers raise the pressure for transmission along the canal to the other stations, where it is reduced to 1,170 volts for the three-phase trolley circuit. In all, there will be four reducing stations about 12 miles apart, the most northerly about 6 miles south of Dayton. A typical station is that which is known as No. 2, at Rialto—typical because all the other reducing substations are to be exactly like it. The equipment consists of three 150-kilowatt, 25-cycle, 33,000-volt to 1,170-volt self-cooling oil transformers connected in delta in both primary and secondary. Each substation is placed at the middle of the station which it is to supply.

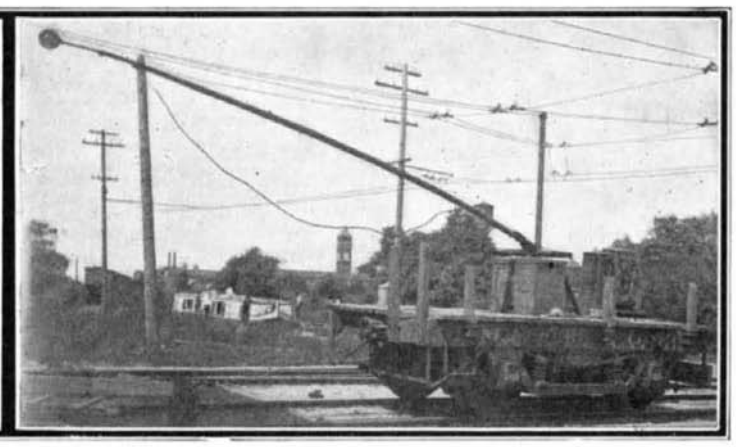
The 33,000-volt transmission line from the transportation company's station No. 1 consists of three aluminium cables made up of seven strands of wire. These are arranged in the form of a triangle at the top



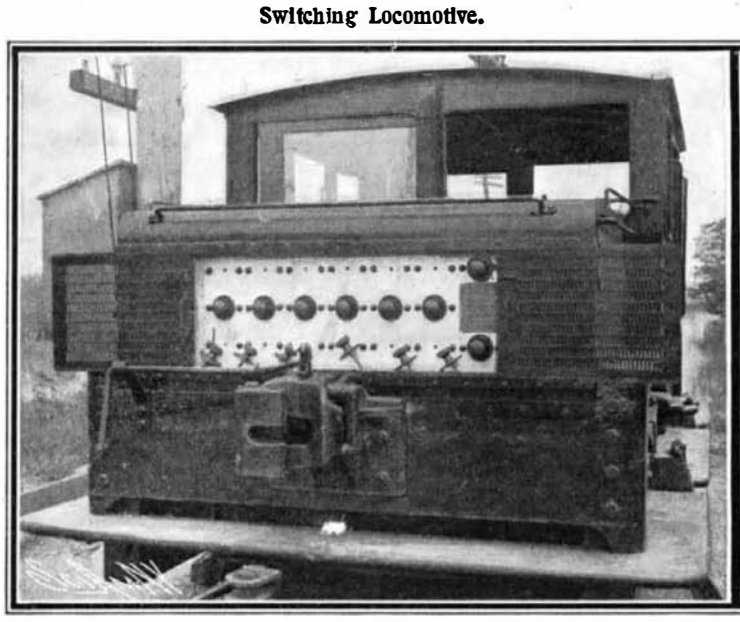
A Scene Along the Canal, Showing Overhead Lines and Track.



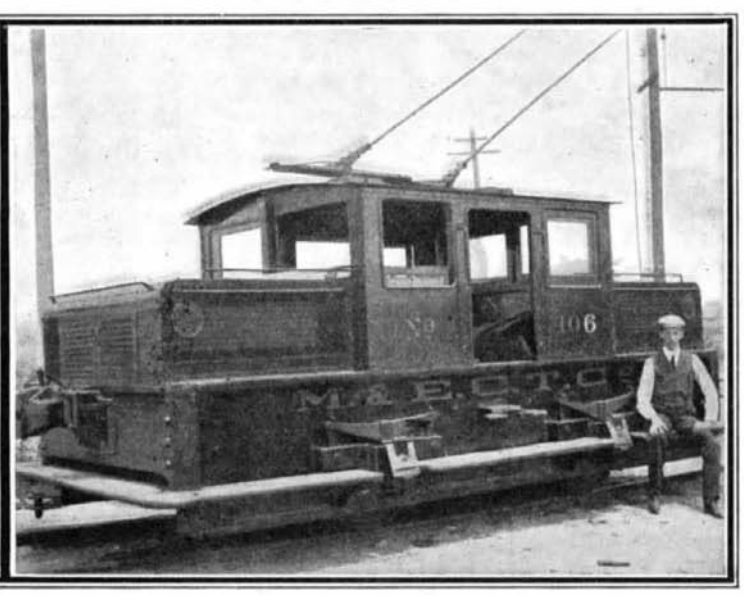
Switching Locomotive.



The Construction Motor.



End of Locomotive Showing the Primary Switchboard.



One of the Standard Electric Towing Locomotives Used on the Miami and Erie Canal.

* 

| From | To | Distance Miles | Width in Feet—Water line | Width in Feet—Bottom | Depth Feet |
|---|---|---|---|---|---|
| Cincinnati | Dayton | 66 | 40 | 26 | 4 |
| Dayton Junction | Junction | 114 | 50 | 36 | 5 |
| Junction | Toledo | 64 | 60 | 46 | 6 |
| Cincinnati | Toledo | 244 | .. | .. | .. |

of the poles, with one wire above and two below. The 4,200-volt transmission line from the generating station to the transportation company's station No. 1 is strung of the same cable as the 33,000-volt line.

The electric locomotives, built by the Baldwin Works, each weigh about 55,000 pounds, and are equipped with two 80-horsepower induction motors, delta-connected, of a normal speed of 720 revolutions per minute. These are connected to the axles through double reduction gearing, and when operating in tandem propel the locomotive at about three miles per hour. Either gear alone will propel the locomotive at double this speed; but under the State law boats cannot be towed at higher speeds. Each locomotive contains three 25-kilowatt self-cooling oil transformers, which reduce the trolley voltage from 1,170 volts or 390 volts to 200 volts for the motors. The motor-changing switch, similar in pattern to an ordinary railway controller, serves to connect the two motors in tandem, or to connect either one to the line and cut out the other, or both. A controller, similar in form to the changing switch, serves to delay the resistance of the rheostat in circuit and to operate the reversing switches, so that the movement of the controller handle in one direction reverses it at the middle position of the handle. At one end of the locomotive is a plug switchboard, by which the primary connections of the locomotive transformers are changed to suit the trolley for each one passing between the high-tension and low-tension sections.

Owing to the large number of low bridges, the extreme height of the standard locomotives is limited to 8 feet, 6 inches, and the extreme height of the switch locomotive, used at the southerly end of the line in Cincinnati, is only 5 feet, 6 inches. Starting and running continuously at three miles per hour, the motors connected in tandem develop 40 horse power each.

### American Commerce in 1903.

Details of eleven months' commerce of the year 1903 are just made public by the Department of Commerce and Labor through its Bureau of Statistics. They show an increase in practically all of the great groups into which the Bureau of Statistics divides the exports and in all of the groups into which it divides the imports. Agricultural products as a whole, show an increase of 74 million dollars; products of the forests, 10 millions; products of the mines, 8 millions; manufactures, 5 millions, and miscellaneous articles, 2 millions. In the single group, fisheries, is shown a slight decrease of a little more than $1,000,000.

The figures for the month of November show a marked growth in exports of manufactures, the total for the month being $34,093,639, against $30,513,512 in November of last year. Agricultural products also show a marked increase in the month, the figures for November, 1903, being $114,172,255, against $83,035,850 in the same month of last year. The increase in agricultural exports occurs chiefly in cotton, of which the value of the month's exports is unusually high.

The increase in exports of manufactures is distributed through many articles, but does not occur, as had been expected, in iron and steel. Discussions in trade circles and in the press during the past few weeks have predicted a revival in the export trade of iron and steel manufactures, but the November figures of exports of this class of merchandise do not justify this prediction. The total value of iron and steel manufactures exported in November, 1903, was $7,988,415, against $8,119,924 in November of 1902, $8,180,193 in November, 1901, and $10,112,721 in November, 1900. For the eleven months ending with November the total exports of iron and steel manufactures are $89,685,201 in value, against $90,136,124 in the corresponding months of 1902, and $94,112,782 in the corresponding months of 1901. Notwithstanding the slight decrease in exports of iron and steel, the total of all manufactures exported during the eleven months ending with November, 1903, is $382,768,127, against $377,757,576 in the corresponding months of last year.

Imports for the month show a decrease of over $8,000,000 compared with November of the preceding year. This decrease is divided between manufacturers' materials, food stuffs, and the group designated as "articles of voluntary use, luxuries, etc." The largest decrease occurs in the group "articles wholly or partially manufactured for use in manufacturing," the reduction in this class being about $3 000,000, as compared with the corresponding month of the preceding year. This reduction occurs largely in iron and steel, of which the importations for the month are less than half those of the corresponding month of last year, the figures for November, 1903, being $2,309,233, against $4,779,093 in November, 1902. For the eleven months ending with November articles wholly or partially manufactured for use in manufacturing show an increase of $15,000,000 over the corresponding months of last year, while articles in a crude condition for use in manufacturing show an increase of $11,000,000 in 1903, as compared with the corresponding months of 1902.

Summarizing the story told by the figures for the month of November and the eleven months ending with November, it may be said that they indicate a growth in exports of manufactures, but that the expected increase in exports of iron and steel manufactures has not developed. Imports of iron and steel manufactures, however, show a decrease in November, 1903, as compared with November, 1902, though for the entire eleven months the figures of iron and steel imports are slightly in excess of those of last year. Importations of other manufacturers' materials also show a slight decrease in November as compared with November of last year, but a marked increase when the eleven months ending with November are considered in comparison with the corresponding months of last year.

These figures of commerce of the eleven months would seem to indicate that the total commerce of the United States during the year was greater than in any preceding year, but that the total exports will fall a few millions below those of 1900 and be about equal to those of 1901, but materially in excess of those of 1902, while the total imports will exceed those of any preceding year, and combined with the exports make the grand total of commerce more than in any earlier year; also that the exports of manufactures will exceed those of 1902 by several millions, but be somewhat below those of the record year 1900, and perhaps 1901.

### New Phenomena Produced With the N-Rays.

Since his discovery of the new form of radiation which he calls N-rays, M. R. Blondlot has been making further experiments on this subject, which he sets forth in a paper read before the Académie des Sciences. When a beam of N-rays is let fall upon a small spark, flame, or phosphorescent substance previously exposed to the sun, or a sheet of platinum at a low red heat, the light which is emitted by these substances is noticed to increase in brightness. In all such experiments, an account of which has been previously given, he uses a source which emits light of itself. It might then be asked what would be the effect of letting the N-rays fall upon a body which is not a direct source of light, but reflects it or otherwise transmits it from an outside source. Following this idea he brings out some interesting facts in the present series of experiments. A band of white paper 0.6 inch long and 0.1 inch wide is fixed vertically on an iron wire support. The room is darkened, and the band is dimly lighted by projecting on it laterally a beam of light coming from a small flame inclosed in a box provided with a vertical slit. The N-rays are now produced in an apparatus consisting of a Welsbach burner inclosed in a sheet-iron cylinder. In the cylinder is a rectangular slit 2.4 inches high and 1 inch wide. The whole is placed inside a lantern-shaped box of sheet iron having an opening opposite the slit which is covered with a sheet of aluminium. In front of the opening is placed the paper band, lighted as above mentioned, and the beam of N-rays falls upon it. If the N-rays are now intercepted by placing a sheet of lead or the hand in their path, the paper strip is observed to become darker and its outlines lose their sharpness. On removing the screen again, the original brightness is restored. It is evident that the light which is diffused from the paper is increased by letting the N-rays fall upon it.

Pursuing this idea it is evident that the diffusion of light is a complex phenomenon in which the elementary fact is the regular reflection, and therefore the next step is to observe whether in fact the phenomenon of reflection of light is not modified by the action of N-rays. This was found to be the case, as was proved by a simple and conclusive experiment. A polished steel knitting-needle is fixed upright in place of the paper band. A source of light is placed inside a box, which is completely closed with the exception of a vertical slit just before the burner. The slit is covered with translucent paper. By placing the slit and the eye in a proper position relative to the needle, the image of the slit is seen reflected from the steel cylinder. At the same time the reflecting surface is exposed to the beam of N-rays coming from the apparatus. It is observed that in such case the action of the N-rays reinforces the reflected image, for if the rays are intercepted by a screen, the image darkens and becomes reddish. The same effect is observed by using a small plane mirror in place of the needle.

An interesting phenomenon is observed when a polished plate of quartz is used to reflect the rays. Here the effect is the same in general, but when the N-rays are let fall perpendicularly to the surface, their action on the reflected light disappears, whatever may be the angle of incidence of the reflected rays. This action may become *nil* or only imperceptible. To have the reflected light from the quartz reinforced by the N-rays, it is not necessary that these should be sent from the exterior to the interior of the quartz, as above. The action still takes place when the N-rays traverse the quartz from the back to the front. In these experiments it is found that the action of the N-rays upon light requires an appreciable time to become manifest and also to disappear. No effect could be observed of the N-rays upon refracted light, although the experiment was repeated in different ways. With a small source of light the effects are sometimes difficult to distinguish with the unpractised eye, but this should not be a drawback to the study of these hitherto unknown radiations. With a Nernst lamp of 200 watts as a source of the N-rays, the effects become striking enough, however, to be observed by anyone.

### Electrical Notes.

An Italian scientist claims to have established that electric tramways are great mediums in the disinfection of towns. He points out that the electric spark, which is so frequent an occurrence to the overhead trolley, and the emission of light from the car wheel when the rail is used for the return current, transform the oxygen of the air into ozone, which has a purifying and disinfecting influence. The high discharges, he says, are frequent enough to influence greatly the atmospheric constituents, especially where the line passes through narrow thoroughfares. They become antiseptic agents.

The plant of the Washington Water Power Company at Spokane, Washington, is about to be started. This is one of the most important installations on the Pacific slope, the length of the transmission being 110 miles. The bulk of the power will be used for mining purposes, 1,200 horse power being delivered to the Standard and Hecla mines, where it will be used for driving compressors, hoists, and similar work. It is anticipated that the operation of this plant will open a rich mining country, which has been thus far neglected because of its inaccessibility. These power electrical plants in the far West have developed a number of "troubles" which are not generally encountered by the engineers in the East, and the Washington plant is no exception. A large portion of the line runs through a marsh, and last winter, after the poles had been planted, the ice formed around the butts and gradually lifted them from the holes. This has been overcome now by fastening a horizontal cross piece to that part of the pole which is placed below the surface.

For more than two years two small factories, one near Leipsic, the other near Hamburg, have been driven successfully by windmills, which are also used as a means of generating electricity for lighting purposes. According to the Elektrotechnischer Anzeiger, the windmills have a diameter of 5 meters and 5½ meters respectively and are mounted on the roof of the works. To insure reliability, the wind wheel itself has no moving parts, the speed regulation being obtained by turning the windmill so as to vary the angle under which the wind impinges upon the sails, which are built of steel sheets. This is performed by a small auxiliary wind motor, and is said to be done so quickly and accurately that the voltage of the dynamo remains practically constant throughout the range of ordinary wind pressures. An automatic switch cuts out the battery connected in parallel with the dynamo as soon as the wind falls below a certain point. In one of the cases mentioned the battery may be divided into two parallel groups when it is necessary to utilize unusually low winds.

At the recent meeting of the National Street Railway Associations at Saratoga, N. Y., Mr. W. L. Emmet, of the General Electric Company, stated that the 5,000-kilowatt Curtis turbine unit built for the Commonwealth Electric Company, of Chicago, had been installed and tested, with successful results. This is the third Curtis turbine put into commercial operation, the first having been a 600-kilowatt machine installed in one of the plants of the General Electric Company, and the second a 500-kilowatt machine erected at Newport, R. I. The first machine has now been in successful daily use for two years. A condenser is being developed which will form part of the turbine base for the Curtis engine. With steam turbines the condenser vacuum is a very important matter, a high vacuum being essential to good steam economy. In the discussion of Mr. Emmett's paper, Mr. J. I. Beggs expressed the belief that future practice would show the steam turbine to fall behind the gas engine just as the reciprocating steam engine is falling behind the turbine. There was, however, a difference of opinion as to this probability, as would naturally be expected. Mr. C. O. Mailloux, of New York, stated that in general the greater first cost of the gas engine plant, entirely aside from the questions of floor space and foundations, would more than offset any operating economy that could be realized from it, except under certain special conditions. Mr. Emmet in replying to the criticisms stated that the actual performance of gas engines under working conditions does not exceed that of steam turbines, and made the important point that the steam turbine is extremely simple in its construction and operation whereas the gas engine is very complicated.