THE WEAVERHAM AND DISTRICT ELECTRICITY SUPPLY.

The scattered and thinly populated rural district in Mid-Cheshire served by the Weaverham and District Electricity Supply Co. is a feature of particular interest in connection with this undertaking. As far back as the year 1874 the idea was conceived to form a local company to supply the Weaverham district with gas, and again in 1894 a movement was on foot to establish an electric supply company, but both these proposals were set aside owing to the heavy capital expenditure that would have been necessitated for mains.

The present company was formed five years ago chiefly for supplying the districts of Weaverham, Acton and Acton Bridge, and the current was switched on for the first time in February, 1912, for 20 consumers, representing 600 30-watt lamps. At the end of the same year the consumers had been increased more than three-fold and the output multiplied by seven.

Several of the surrounding districts were constantly appealing to the company to extend their supply into their areas, and the directors, in view of the fact that the initial scheme had been a success, finally decided to extend the system and applied for statutory powers as regards Milton

Low-tension Overhead Line, with B. of T. Guards.

Gorstage, Cuddington, Sandiway, Oakmere and White Gate. The supply was first given over this new area on December 22nd, 1913, and some 30 consumers were connected to the mains.

At the end of last year, 180 consumers were connected to the mains, representing 8,500 30-watt lamps.

The scattered nature of the area served, which will be seen by reference to the plan which we reproduce, involved special consideration in view of the difficulty of keeping down the capital outlay on mains, and at the same time meeting the requirements prescribed by the Board of Trade as to the variation of pressure.

The original supply was on the three-wire direct-current system at 460/230 volts, consisting of some 5½ miles of feeders and distributors, run overhead with three exceptions where for local reasons the roads were crossed with lengths of underground cable. The direct current area of the supply is at present served from the generating station by a ·1, ·06, ·1 sq. in. feeder terminating at a pole type distribution box adjoining the Gate Inn, Weaverham, at which point it passes through double-pole switches and fuses, and distributors are taken off for Weaverham, Acton and Milton townships. A second feeder is run from the generating station to supply the Weaverham Refining Co.'s works at Acton Bridge. Provision is also made for a third feeder to meet the foregoing network at Acton at a point called Wall Hill, 3¼ miles from the station.

The Sandiway and Cuddington extension consists of nearly four miles of 7/16's S.W.G. concentric paper-insulated lead-covered and armoured 3,000-volt main, laid

Transformer Kiosk at Sandiway.

direct in the ground from the generating station to a kiosk situated at the crossroads at Sandiway. On this route several large houses have taken current, reducing the voltage by means of transformers to their own particular needs.

The kiosk consists of a substantial ornamental cast-iron pillar mounted on a concrete base, with the high-tension and low-tension apparatus kept quite separate. To meet the present demands, and as duplicates there are two 15-K.V.A. oil-cooled transformers stepping down from 3,000 volts to 230 volts, and two high-tension main oil switches. Between the high-tension cables are bifurcating boxes with links, by means of which either or both transformers can be connected up. The door on the high-tension side is interlocked with the main switch, so that it cannot be opened until the switch is in the "off" position, making the kiosk dead. The switch can also be worked by means of a long detachable handle through a hole in the kiosk door closed by a shutter when not in use.

A second high-tension oil switch is fixed in the H.T. section for controlling a feeder which is at present tapped to supply two pole type transformers serving three large houses whose grounds are passed, but this feeder will eventually be extended into the low-tension distributor by

Interior of Generating Station at Weaverham.

means of step-down transformers at different points, in order to boost the voltage when the load increases and makes this necessary.

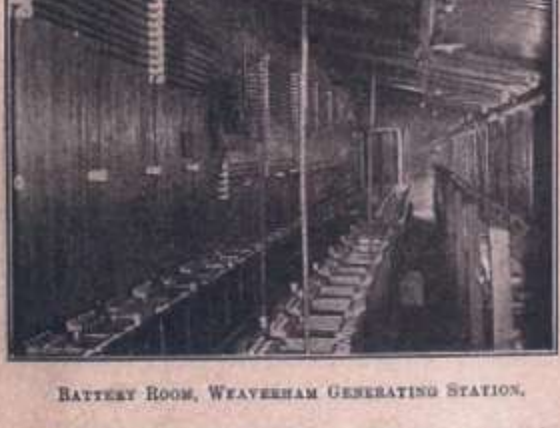
The low-tension section of the kiosk is provided with its own door, and contains switches with porcelain handle fuses controlling the outgoing distributors, the ends of which are sealed in bifurcating boxes.

Owing to the position of the kiosk it was considered advisable to cross the roads underground, and run some

Weaverham and District Electricity Supply Area.

distance to terminal poles, which are provided with lightning arresters, and up which the armoured cables are taken to pole type bifurcating boxes, from which overhead bare copper conductors continue.

The low-tension single-phase 230-volt bare copper distributors are carried on insulators mounted on swan-neck brackets, and a cross-arm with two insulators is fixed on



Battery Room, Weaverham Generating Station.

each pole above the line insulators, with bare copper wires taken over each insulator and connected to the lower conductor by means of brass tee connectors, to form a "V" each side of the pole, the lower conductor being earthed at the generating station. By this means the upper conductor, should it break, cannot fail to come into contact with the lower earthed conductor, as required by the Board of Trade.

The site selected for the generating station adjoins the River Weaver, and was presented to the company by Lord Barrymore, who owns considerable property in the district; plenty of water is always available, and fuel can be brought by boat as desired.

The plant in the original scheme consisted of two 18-kw. d.c. 460/500-volt generators, driven by two horizontal British Westinghouse gas engines fed from a Dowson and Mayson suction-gas plant. This plant is of such capacity, and the pipework so arranged that each producer is capable of serving either engine, or, if necessary, both engines can be run on either producer.

Particular care was given to the switchboard; all the machines are protected by double-pole enclosed fuses and automatic switches. On the left-hand side of the switchboard the conductor is arranged for the positive side of the system and the right-hand side for the negative.

The switchgear is fool-proof; in the case of the booster panels the switch is interlocking so that it is impossible for the booster armatures to be short-circuited whilst the fields are excited.

The battery panels are provided with instruments recording charge and discharge, and wattmeters recording units put in and taken out of the battery, the charge side of the meters reading slow and enabling the staff to put back the additional amount of energy required, based on the efficiency guaranteed by the makers.

The new plant installed consists of a 65-kw. 460/500-volt direct-coupled Johnson & Phillips generator, driven by a vertical four-cylinder Hindley engine taking gas from a Salmon & Whitfield gas plant. The latter is designed to burn low-grade anthracite, and is capable of dealing with all three engines. An electrically-driven fan is provided to facilitate starting, and also the engines are started up by the

Main Switchboard, Weaverham Generating Station.

"Leigh Osborn" patent starting gear, the combined arrangement enabling either engine or gas plant to be started up under five minutes.

Two 16-kw. Johnson & Phillips motor alternators link up the a.c. and d.c. systems. The d.c. machines are 460/500-volt, compounded when running as generators to give a flat voltage curve, and owing to cyclic variations experienced in a gas-driven station, as motors to give a constant speed. The a.c. machines are single-phase for 300 volts 50 periods, the fields being excited at 460 volts from the main switchboard.

One 14-kw. three-machine booster operates with the storage batteries, or, if desired, in series with the three-wire feeders.

The low-tension switchboard was extended by the addition of a 65-kw. generator panel; two d.c. motor and two a.c. generator panels for the motor alternator; a transformer and synchronising panel for the primary sides of two 15-k.v.a. step-up single-phase oil-immersed transformers, arranged through D.P. switches and fuses so that either or both can be placed in work. The transformers step up from 300 to 3,000 volts, and from the high-tension sides leads are taken to a high-tension switchboard consisting of two steel cubicles built upon angle-iron framework, which contain two sets of isolating switches, two automatic oil switches, and two high-tension voltmeters.

This board puts either one or both of the transformers into the H.T. line.

All the cables are drawn through earthenware pipes, the H.T. cable terminating inside the cubicles: provision has been made at either end of the H.T. board for another feeder and an A.C. generator panel.

Both the H. and L.T. switchboards and cables were also made by Messrs. Johnson & Phillips.

The battery room contains two 500 ampere-hour batteries by the D.P. and Premier Battery Companies, and provision has been made in the containing boxes for the addition of more plates to increase the capacity to 700 ampere-hours. All the leads are bare copper rods supported on porcelain insulators.

The company's charges for energy are on a very reasonable basis, being 6d. per unit for lighting; 1½d. for heating and cooking; and 2d. per unit for power up to 1,000 units per quarter, all in excess being charged at 1d. per unit. As an alternative, the consumer can be charged £4 per K.V.A. of maximum demand, plus ¾d. per unit.

To deal with smaller classes of consumers, the company supplies at a fixed charge of 3s. 3d. per quarter per 30-watt lamp, or 400-watt iron, subject to the latter being used during non-lighting hours. Financially the company has been very successful; at the end of 1912, after only nine months' working, a dividend of 5 per cent. was paid, after allowing 2 per cent. depreciation and wiping 20 per cent. of the preliminary expenses off. At the end of 1913 the same dividend was paid and depreciation allowed.

The contractors for the scheme were Messrs. Johnson and Phillips, Ltd., who carried out the work to the specification of Mr. A. J. Leigh, the company's consulting engineer, the resident engineer being Mr. F. Foster.

AN INVESTIGATION OF DIELECTRIC LOSSES WITH THE CATHODE-RAY TUBE.*

By JOHN P. MINTON.

(*Concluded from page 93*)

The dielectric loss, power factor, and current have been determined for a number of different insulating materials and have been plotted against the applied voltage, the temperature, and per cent. absorbed moisture in the case of paper.

All the tests embodied in this paper have been made at 60 cycles with a generator which produces very nearly a sine wave. The tests were made in good transformer oil to avoid corona, and the brass test terminals were either 20 cm. or 25.4 cm. in diameter and 0.5 cm. thick. They were square-edged and arranged so that they could be clamped into position after good contact was obtained.

A large number of tests have been made on various kinds of varnished cloths. The different test samples were about 30 cm. square, and were built up of separate sheets of the same size to the required thickness. In figs. 7 to 10 are illustrated some of the results. For sample No. 1, it is seen that the losses at 138 deg. Cent. are forty-five times as great as they are at 25 deg. Cent., and for sample No. 2 the ratio is twenty-five to one. All the curves are consistent in showing that No. 1, No. 3, and No. 2 represent the order in which the samples should be placed, as far as their insulating value is concerned.

It will be interesting to compare these results on varnished cloths with those on some others. In one instance, with another varnished cloth at about 200 volts per mil and 100 deg. Cent. the watts per cu. cm. were about 4.0, the per cent. power factor 98, and the milliamperes per sq. cm. about 0.050. Comparing these values with those given in figs. 7 to 10, one will note the following points: watts per cu. cm. at 200 volts per mil and 100 deg. Cent. are about twenty-three times as great for the above cloth as they are for sample No. 1; the current value is about five times as great and the power factor about four and a half times as great for the former cloth as for the latter. On the other hand, another sample of varnished cloth has yielded a power factor at 100 deg. Cent. of about 13.5 per cent. compared with about 20 per cent. as shown in fig. 9. These numbers show in a striking manner the difference likely to be found in various kinds of varnished cloths, and they also show that tests of dielectric losses yield most valuable results. When a loss of 4.0 watts per cu. cm. is observed in a piece of insulation whose volume is about 250 cu. cm., it means that about a kilowatt is producing heat in it. Under such severe conditions a piece of insulation will always be punctured within a few minutes.

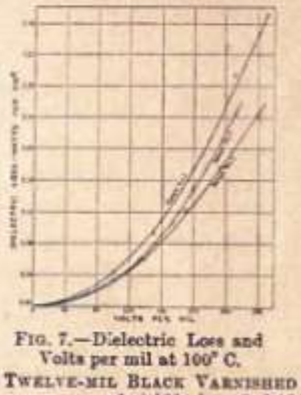


Fig. 7.—Dielectric Loss and Volts per mil at 100° C.

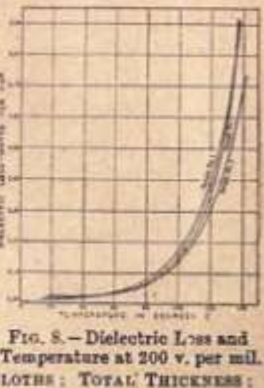
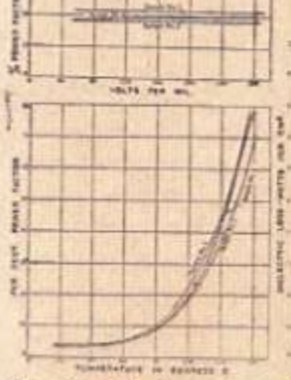


Fig. 8.—Dielectric Loss and Temperature at 200 v. per mil.

Twelve-mil Black Varnished Cloths; Total Thickness: 1, 0·1214 in.; 2, 0·1245 in.; 3, 0·1093 in.

Samples of pressboard were cut, 30 cm. square, from regular 3/32-in. stock, and after drying were impregnated with good transformer oil. Each of the test pieces consisted of one sheet of oil-treated pressboard of the dimensions given above. Figs. 11 to 13 show a set of curves taken on pressboard sample No. 1.



Figs. 9 and 10.—Power Factor of Varnished Cloths.

Fig. 11.—Dielectric Loss and Volts per mil: Oil-treated Pressboard 0·193 in. thick.

Results on two other samples of oil-treated pressboard, of the same kind as sample No. 1, show that a peculiar phenomenon occurs as the applied voltage is increased. One is surprised to observe large variations in the losses, power factors, and current values for the same insulations under the same voltage and temperature conditions. The explanation of these variations is found in the quantity of absorbed moisture the samples contained. In order to determine how the losses, power factors, and current for oil-treated pressboard are affected by the quantity of absorbed moisture, a number of samples of the same kind of pressboard as tested above was taken.

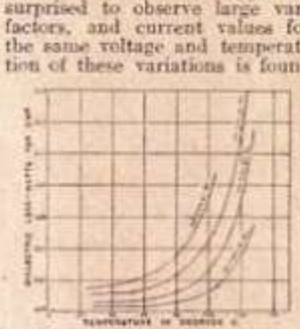


Fig. 12.—Dielectric Loss and Temperature.

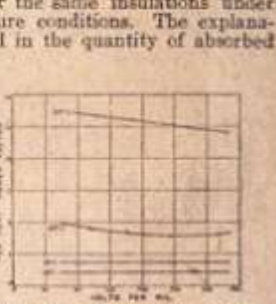


Fig. 13.—Power Factor and Volts per mil.

Oil-treated Pressboard.

In figs. 14 and 15 will be found results taken at 200 volts per mil and at three different temperatures on several sheets of pressboard containing different percentages of moisture, which show the enormous influence absorbed moisture has on the losses and power factors for porous insulation capable of absorbing moisture.

* Abstract of paper read before the American Institute of Electrical Engineers, July 2nd, 1915.