Additional Power Plant at Elwood- cont.

"With respect to item 3 above which is for provision of the generator (control) panel only of the additional switchgear I recommend that this be ordered from the Aust. General Electric Coy. without calling for tenders. My reason for this is : I consider it desireable that all generator panels should be similar in design and construction with a view to reducing the risk of error in operating in times of emergency."

In the event, Appropriation N° 70/3 (Corres. Sec's 1912/19886) for £958 was approved on the 14 July 1913 with the work expected to take 12 months to complete, and which in fact was completed on 18 Mar. 1915. (cross check if possible)

Information gained from an inventory drawn up when the power house was being dismantled disclosed that the M.G. set was of 'GANZ' (Hungarian) manufacture. It was supplied by.....? ✡

In May 1913, the Electrical Engineering Branch of V.R. was formed to centralize expertise in electrical matters. (Harrigan, p 280) The head of the new branch was titled Chief Electrical Engineer. The first appointee to this position was logically William Stone. The electrification of the suburban rail system brought about this change.

The extra power from the M.E.S. Coy turned out not sufficient to power the steady increase in traffic on the line. The expectation that the new large power station being constructed at Newport for the electric trains would be supplying power during the middle of 1915 was dashed by the outbreak of the Great War on the 4 Aug. 1914. The resultant disorganisation of civilian industry, manufacturing & shipping caused a negation of the premise of Newport power in 1915. Consequently, existing installations had to 'hold the fort' pending more stable times.

The introduction of nine new single truck side door trams at Elwood during 1913 meant that at the end of that year 19 motor cars were nominally available for service. Allowing that all would not be available at all times owing to overhauls, painting etc, the Chief Electrical Engineer (C.E.E.) still had to direct that no more than 16 S/T trams were to be in service at one time. Inaddition for the same reason trailer car operation was discontinued until further notice. A sidelight to the situation confronting management was contained in the 'Inwards Correspondence Register' at P.R.O. (check date) in which it was noted that the boiler from steam loco. N° Y-415 was temporarily in use at Elwood, reason unknown. (Des Jowett) (3etween April and July 1914)

The commissioning of the Elwood substation from 18 Dec. 1918 resulted in the steam plant being taken out of service. The old plant would have been on standby until the new power source had settled in. A letter to the M.E.S. Coy indicated that their supply of power to Elwood power house was discontinued on 6 July 1919.

✡ From Victorian Government Gazette; 21 January, 1914, page 197.

"N° 1302 - Supply and delivery and guarantee run of one 50 Kw Motor Generator and accessories for £297 -- supplied by Falkiner - Boll Electric Coy."

(14)

20

POWER SUPPLY for VICTORIAN RAILWAYS: ELECTRIC STREET RAILWAYS.

For bookkeeping purposes, in May 1919, the old Elwood steam plant was estimated for the current replacement values:-

	£
Two Babcock & Wilcox boilers	3,180
Feed pumps, heater & piping	1,370
Two X 100 Kw Belliss & Morcom / General Electric Coy, engines & generators	4,840
Switchboards & equipments for above	330
GANZ - 50 Kw motor generator & switch boards	750
Pirani - battery booster & switchboard	1,000
Tudor - storage battery & access, 266 cells, 592 amp/hour	4,560
Lighting motor generator	100
Total for Plant	£16,130
Power House buildings	£2,083
Grand Total	£18,213

(taken from Commissioner's minutes, 13/5/1920, Corres. Sec's 1919/2379)

STATEMENT of DISPOSAL of ELWOOD POWER EQUIPMENT.

released by the installation of the substation, and recommended disposal.

2 x 100 Kw steam driven generators	Tenders have been received for purchase and removal of this plant. The possibility of rewinding the generators for use as rotary converters has been looked into and found impracticable. Sold to Cameron & Sutherland for £1,615-
2 x Babcock & Wilcox boilers, feed water heater, feed pump & chimney.	These have been taken over by Newport Workshops. £600 - VALUE.
1 x Battery & battery charging plant.	The battery has reached the end of its useful life and cannot be disposed of as a battery. Part of this battery is still being used as a tripping battery for the new substation. All the good negative plates in the remainder of the battery have been disposed of to the P & M TT. Sold for £62 - 8 - 0. As soon as the new operating battery for the substation comes to hand it is proposed to call tenders for the purchase of acid, lead, plates etc.

With regard to the battery charging plant, it is proposed to retain this for the present until we investigate the possibility of using this plant for negative boosting the return circuits in the tramway. (This refers to the "PIRANI" battery booster.) L.W.R.

POWER SUPPLY for VICTORIAN RAILWAYS.

ELECTRIC STREET RAILWAYS.

Disposal of Elwood Power House Plant (cont)

Switchboards:-	These have been 'released' (recycled) in connection withthe provision of additional feeders for Elwood and for the Sandringham substation.
Motor Generator (GANZ)	This machine which has been used for converting from 200 volts a.c. (sic)(400 ?) to the 550 v. d.c. tramway; it is proposed to retain for use in connection with the Lecture Theatre at the Electric Running Depot, Jolimont.
Battery Silt:	sold to J.E. Stone - £65 - 14 - 0
Lead linings etc.	sold to Moreland Metal Works - £311 - 10 - 6
Grids & lead :	sold to J McIlwraith - £77 - 19- 9

The above info. was taken from a memo. from the Accountancy Branch, dated 3 June, 1920 (Corres. Secy's 1919/ 2379)

It is of interest to record two proposals put up for further use of the old Elwood generating plant:-

1/ to supply power temporarily for the new Sandringham - Black Rock tramway owing to delays in equipment delivery caused by the World War 1. (presumably it was intended to transmit the 550 v. d.c. by a heavy feeder to Sandringham; alternatively, the cost of transferring boilers, generating sets, switchboard, battery booster & battery would appear to be unduly high. (LWR) ?

2/ purchase or lease from V.R. by Footscray Tramways Trust for reason of delay in equipment supply due to W.W. 1. (Commissioners' Minutes, Secy's 1919/2379 & 1918/ 16664.)

The proposal above to use the Ganz motor generator to provide 550 v d.c. power to the Lecture Theatre, E.R.D. was not carried out; a cheaper method was used, viz. d.c. power was purchased from the Hawthorn Tramways Trust and tapped off the overhead wiring in Batman Ave. The Electric Running Depot & Lecture theatre housed the 'skeleton electric motor coach', which was used for practical instruction to electric train drivers. The motor coach was powered with the tramway voltage because the Commissioners considered that the use of 1,500 volts was potentially too dangerous. The theatre was and is located on the north side of Batman Ave, west of the old Olympic swimming pool. (1996)

As mentioned in Commissioners' minute, dated 11 June 1920 in Corres. Sec's 1919/2379, The Chief Accountant refers to ....."certain of the old (Elwood power house) buildings have been re-erected at Jolimont (rail yard) and that their value for re-erection was about £250-".....

There were many old gal iron buildings in the Jolimont railyards & used for a variety of service purposes i.e. car cleaners, carriage & wagon builders & Way & Works 3ch depots. It is not known the purpose the old Elwood buildings were put to.

(15A)

22

POWER SUPPLY for VICTORIAN RAILWAYS ; ELECTRIC STREET RAILWAYS.

Following the decision of the Government to authorise the electrification of the suburban railway system, the Commissioners acted to set up an "Electrification Committee". The Comm' ittee to "be maintained in existence during the progress of conversion of the suburban railways to electric traction and the carrying out of the various auxilliary schemes allied therewith.....". The "auxilliary schemes" included the power supply for the E.S.R's.

A document from the Commissioners dated 15 March, 1913 appointed the following to serve on the Comm'tee:-

Mr E.B. Jones, Acting Secretary for Railways- Chairman of the Committee.

Mr W.M. Shannon, Chief Mechanical Engineer - representing the Rolling Stock Branch.

Mr W Stone, Electrical Engineer, " " Electrical Branch.

Mr T.B. Molomby, " " Transportation Branch.

Mr W.R. Rennick, " " Way & Works Branch.

Briefly, the duties of the Committee was to act as the medium between Mr Merz's staff; (Merz& Mc Lellan , consulting electrical engineers in U.K., who investigaed, designed & supervised the electrification project.) and the Railway Department.

b/ supply Mr Merz's staff with any additional information required in connection with the work.

c/ observe the various stages of the work.

d/ maintain an oversight of the expenditure.....

e/ hold meeting at frequent intervals, record the proceedings ..... and how the various matters associated with the work stand.....

The Commissioners desired that all questions arising from the electrification reach them through the Electrification Committee.

(16)
23

POWER SUPPLY for VICTORIAN RAILWAYS ELECTRIC STREET RAILWAYS.

ELWOOD SUB-STATION.

The decision of the Victorian Government in Dec. 1912 to electrify the suburban railway system provided for a cheap and powerful source of electricity from a new Newport Power House. This supply was also to be available for the St Kilda - Brighton E.S.R.. The original power plant at Elwood was always regarded as a temporary plant. Since the inception of the E.S.R. the steady increase in patronage on the tramway could not be adequately handled. owing to the limited output of the plant. This tramway was the first permanent electric line in Melbourne (1906) and IT only needed the provision of a suitable substation to gain the benefits of a new and large station at Newport. The sooner this substation could be provided the sooner the necessary improvements could be made to the tram service.

The suburban electrification scheme was designed in the main by Charles H Merz of Merz & McLellan, consulting electrical engineers of the U.K. in conjunction with the newly formed Electrical Engineering Branch of V.R. On the question of the need for increased power for the E.S.R. the following is taken from notes from the Commissioners to the Minister of Railways in Dec. 1914. :-

"An increased car service to commence on the E.S.R. in Nov. 1915 would necessitate the provision of additional power to the extent of 90%.....power from Newport P/station was expected to be available about July 1915". "Power for operating the line should be made available before Nov. 1915 to avoid (the need for) duplication of the existing plant".....

Mr Merz's proposals for Elwood was for a substation receiving H.T. supply of 3-phase 25 Hz. — A.C. at a pressure of 20,000 volts. This was transmitted by an underground cable from the Jolimont substation (originally named Princes Bridge). A parallel cable supplied similar power from Jolimont s/station to Middle Brighton S/S. In addition a cross connection cable was provided between Elwood & Middle Brighton S/S's. The cable in each case was .1 of square inch in cross-section. These cables "were paper insulated, lead covered and wire armoured with a protective serving of heavily compounded hessian tapes between the lead and the armouring and again over the armouring". p. 23 * " The cables were mainly laid in trenches in the streets..... owing to limited space.....alongside railway lines." * The purpose of the Elwood-M-Brighton subs cross connection was that in the event of failure or an accident to either of the feeders, supply could be maintained to both subs via the other feeder. The cable routes from Jolimont S/S was as follows —

* Electrification of Metro. Rlys of Melb. - The Australian Industrial & Mining Standard 1919

(17)

POWER SUPPLY for VICTORIAN RAILWAYS ; ELECTRIC STREET RAILWAYS.

ELWOOD SUBSTATION.

In Nov. 1914, the tender for £17,616 for supply & delivery of Electrical Equipment for the Elwood & Spencer St. substations from the British Westinghouse Manufacturing Coy. U.K. was accepted. The equipment for Elwood to be supplied as soon as practicable , Spencer St s/s plant later. (from notes on Auxilliary Schemes; Electrification, N° 22239 - Dec. 1914.)

One of the important questions to be answered was where to locate the Elwood s/s. Mr Stone wrote to Chairman, Electrification Committee on 23 Apr. 1915 with which he forwarded b.p. N° 1321, dated 20 Apr. 1915 showing the general layout of the buildings comprising the steam power house complex at Elwood; also a tracing on the same scale showing the dimensions & gen. arrangement of the proposed s/s. The various proposals being considered for siting the s/s were as follows:-

Proposal 1/ placed between N° 1 & 2 car sheds - west of the new battery room, but nearer to Head St.; covering the ground currently occupied by the store room & part of the coal shed.

Proposal 2/ on the St Kilda St. frontage, generally on the site of the existing office.

Proposal 3/ between the tracks extending from the rear of N°s 1 & 2 car sheds - east of the alignment of the rear of these sheds. (E.E. Bch. Drg. N° 1321A, dated 20/4/'15.)

Mr Stone approved of the 3rd option because he considered it undesireable that this s/s should be located amongst wooden buildings, owing to the the fire menace. He considered that position N° 2 would be the best for the "appearance of the s/s", but it also would be the most costly.

In an annotation, Mr E.B. Jones, Chairman of Elec. Comm'tee suggested a 4th alternative site, - east of site N° 3 - close to the curves of the loop connecting the two car sheds.

In a memo dated 1 July, 1915, Mr Stone wrote to the Chairman, E.C. on the subject and stated that he understood that the St Kilda - Brighton E.S.R. "will in all probability be handed over to a body which will be appointed to deal with the tramways of the Metropolitan area". (Sec's 15/6614)

Mr Stone continued with the following questions:-

a/ whether the Dep't will entertain handing over this substation to the body which may take over the St Kilda - Brighton Electric Line?

b/ whether the Dep't will supply that body with power beyond the time which is necessary to allow that body to obtain power from some source of their own?

c/ whether the Dep't will keep this s/s on Dep't property and at all times retain control of same?

Mr Stone asked that should the Comm'rs decide that....."it is advisable to retain the s/s as a part of their transmission system whilst at the same time they hand over the line together with the offices & car sheds which are a part of the system to the other body it may be desireable to place the s/S on a portion of the land which is outside the area which could be properly be handed over with the line".

Mr Stone offered his opinion that the s/s shouldnot be handed over to any outside body whatever.

Consequently a fifth alternative site for the s/s was proposed. This was to the east of the eastern boundary of the Elwood Power Station reserve and facing southerly towards Head St. Some doubt was entertained about the wisdom of constructing an expensive substation with the possibility of the E.S.R. being transferred to another control body. The Commissioners decided on 9 Aug. 1915 to proceed with the s/s and in the event of a central tramway authority taking over the E.S.R., the Commissioners would be in a position to sell the elec. energy with advantage. The " approved of the s/s being placed outside the Power House boundaries. During the beginning of 1915 the Elec. C'tee decided to amend the spec. for the rotary converters on order from British Westinghouse. The change involved the voltage being raised from 500/550 to 550/600. The reason was to bring this equipment in line with the plant of the Prahran & Malvern T.T. having in mind the probable amalgamation of the tramways in Melb. The Elec. C'tee passed the recommendation to the Comm'rs on 26 Feb. 1915. (E.C. min. 1623 (69) 26 Feb. 1915)

The Commissioners, having decided to go ahead with the construction of the s/s as much because of the contract for plant already let with British Westinghouse, instructed Mr Stone to investigate the arrangements applying to the supply of power by Melb. Electricity Supply Coy. to P & M TT. (E.C. min. 77- 9 July 1915, Sec's 15/6614).

In a memo to the Chairman, Elec. C'tee, dated 29 July, 1915, Mr Stone C.E.E. advised having interviewed Mr Clements, Engineer & Manager of the M.E.S. Coy.. Mr Stone learned ".....that current is supplied to the P & M at the direct current terminals of the converters, that is the M.E.S. Coy. keeps control not only of the high tension transmission system & static transformers, but also of the machinery which is used to convert the current from A.C. to D.C....." "...this is in harmony with the proposal which has been made with respect to the Elwood s/s....." and the supply of current to a body which may take over the control of the E.S.R..

In Aug, 1915, arrangements were being made with the Lands Dep't for a piece of land east of the power house reserve to be transferred to the control of the Commissioners. E.C. min (73) of 19 Oct. 1915, states that the construction of Elwood s/s should be commenced as soon as possible and that Mr Rennick (Way & Works Bch) is to have the plans expedited. This urgency was due to shipments of plant from overseas being expected in Jan. 1916. (E.C. min 33 (f) of 29 Oct. 1915)

(19)

POWER SUPPLY for VICTORIAN RAILWAYS ELECTRIC STREET RAILWAYS.
CONSTRUCTION OF ELWOOD SUBSTATION.

Work commenced in Nov. 1915 by the V.R. Dep't using day labour. (E.C. Min. 26/11/'15)
"Providing the contractors adhere to their promises respecting the supply of materials, the building will be sufficiently advanced by 15 Oct. 1916 to enable the erection of the elec. equipment to be commenced" (E.C.M, 16/6/'16.)
Progress of work:- 16/6/1916:- 68% of brickwork has been done.
E.C.M of 30/6/1916:-"in view of uncertainty respecting supply of switchgear, it was advisable to hold up as much of the cell work as possible without interfering with the completion of the building ssufficiently to enable it to be roofed"

E.C.Min.- 14/7/'16:-"suspend interior cell work as far as possible pending some definite information as to the type of switch gear to be installed, but that the rest of the building , including the roof, would be completed as soon as practicable."

E.C.Min.-14/7/'16:- 86% Of brickwork done.

E.C.Min.-19/9/'16:- Elwood substation crane- main girders were originally intended for Glenroy s/s; it would be necessary to make some alterations before they could be erected at Elwood.

E.C.Min.-4/7/'17:- the third converter set is also being left unfinished to avoid additional work should it be found necessary to transfer it to Sandringham....."

E.C.Min.-25/3/'18:- "Elwood substation should be brought into operation as soon as possible & prior to the Sand'ham s/s if sufficient elec. equipment is not avail- to enable both to be completed concurrently.....this will enable the heavier cars to be put into service on St Kilda-Brighton line."

E.C.Min.-13/1/'19:- official record; Elwood s/s was brought into regular commission on 20 Dec.1918, and that with the exception of minor defects the plant has been running satisfactory. (sic)

EC Min.-(18)- 26/2/'19:- the plant in the Elwood s/s has now been running satis- factorily for 2 months and the steam plant is no longer required as a standbyand instructions will be issued accordingly."

E.C.Min.96a- 26/2/'19:- the question of disposing of this plant to the Footscray Tramway Trust is under consideration."

E.C.Min. 52-17/6/'19:- the Footscray T.T. has advised that it will not require the steam generating plant & instructions have now been given for the boilers and chimney to be transferred to the Newport Workshops."
By 2 Sept. 1919, it was reported that the boilers and chimney had been transferred to Newport. It was also reported that as traffic was increasing rapidly it may be necessary to put another six cars into service (EC min.(59), 2/9/'19) and additional track feeders (min. (54)-16/9/'19.

(20) 27

Power consumption per passenger carried is about 50% greater, relatively, with the bogie cars than with the single truck cars.

E.C.Min.(61d)- 23/1/1920:- the Chairman mentioned that the traffic on this line had been increasing very rapidly and that if further increases took place it will be necessary to run two motors (cars) coupled on the multiple unit system in order to cope with same."

E.C.Min.- 7/5/1920:- Retirement of Mr Stone- Chief Electrical Engineer. V.R.

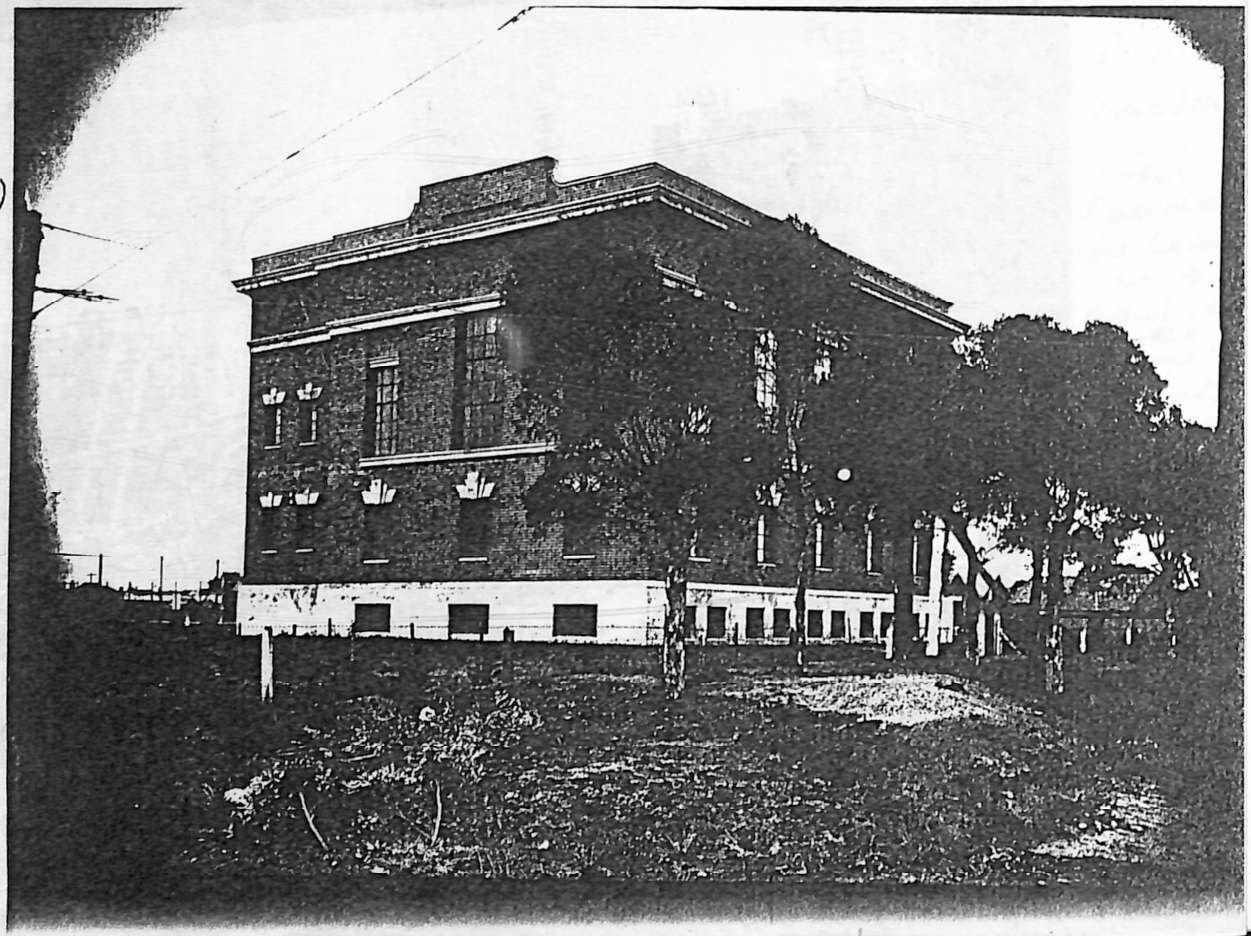
E.C.Min.- 7/5/'20:- "the provision of additional converting plant at Elwood s/s has become a matter of extreme urgency in view of the growing traffic and the length of time it takes to obtain equipment. Arrangements have accordingly been made with Mr Grove (Merz & McLellan rep. in Melb.) for plant to be ordered under the existing contract with the Metropolitan Vickers Ltd."

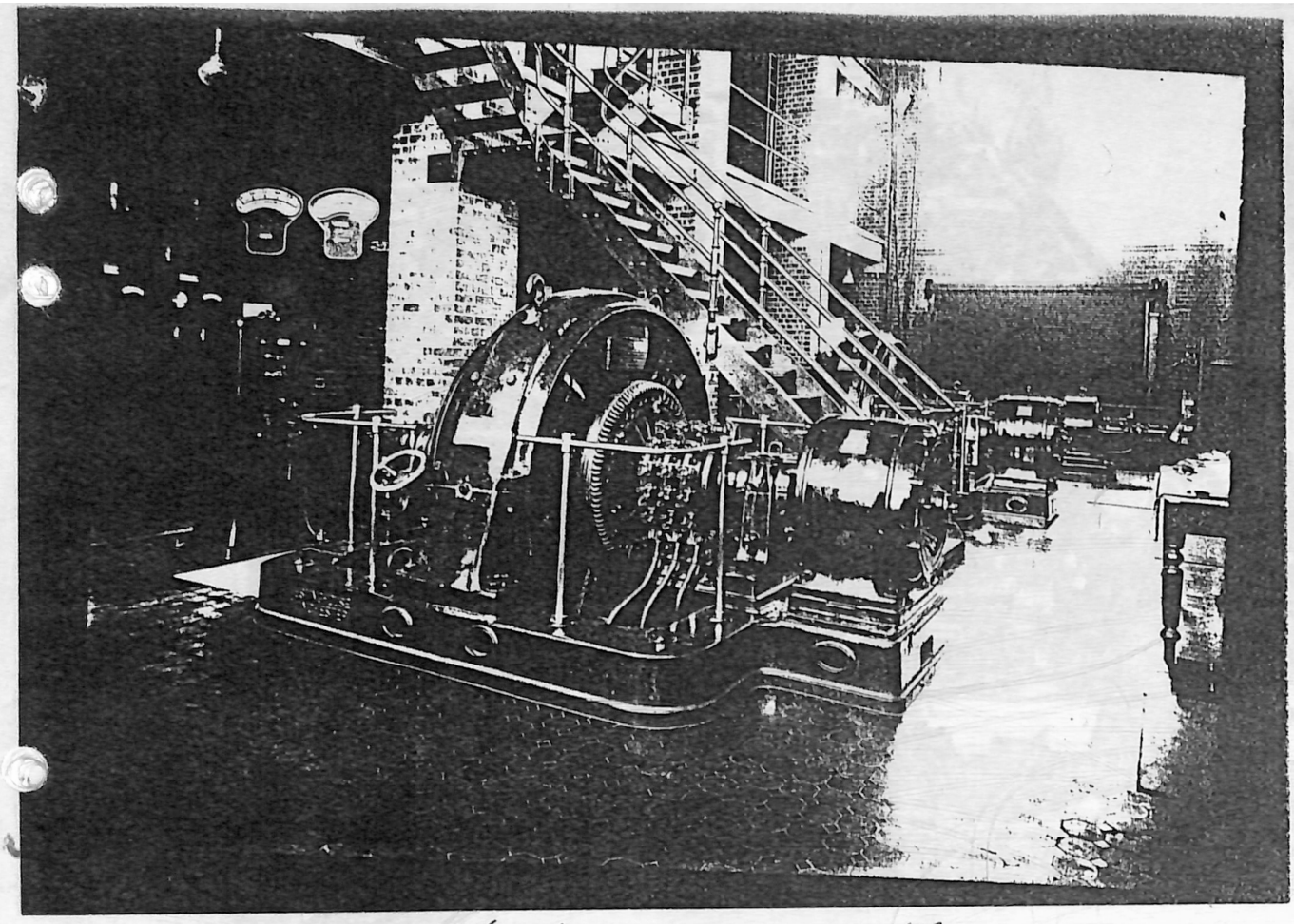
E.C.Min.- 18/6/'20:- "an additional rotary converter has been ordered for Elwood s/s and one for Sandringham s/s from the Metro. Vickers Ltd." as an extra to the existing contracts.

Elwood Sub-station. Southern face towards Head St.

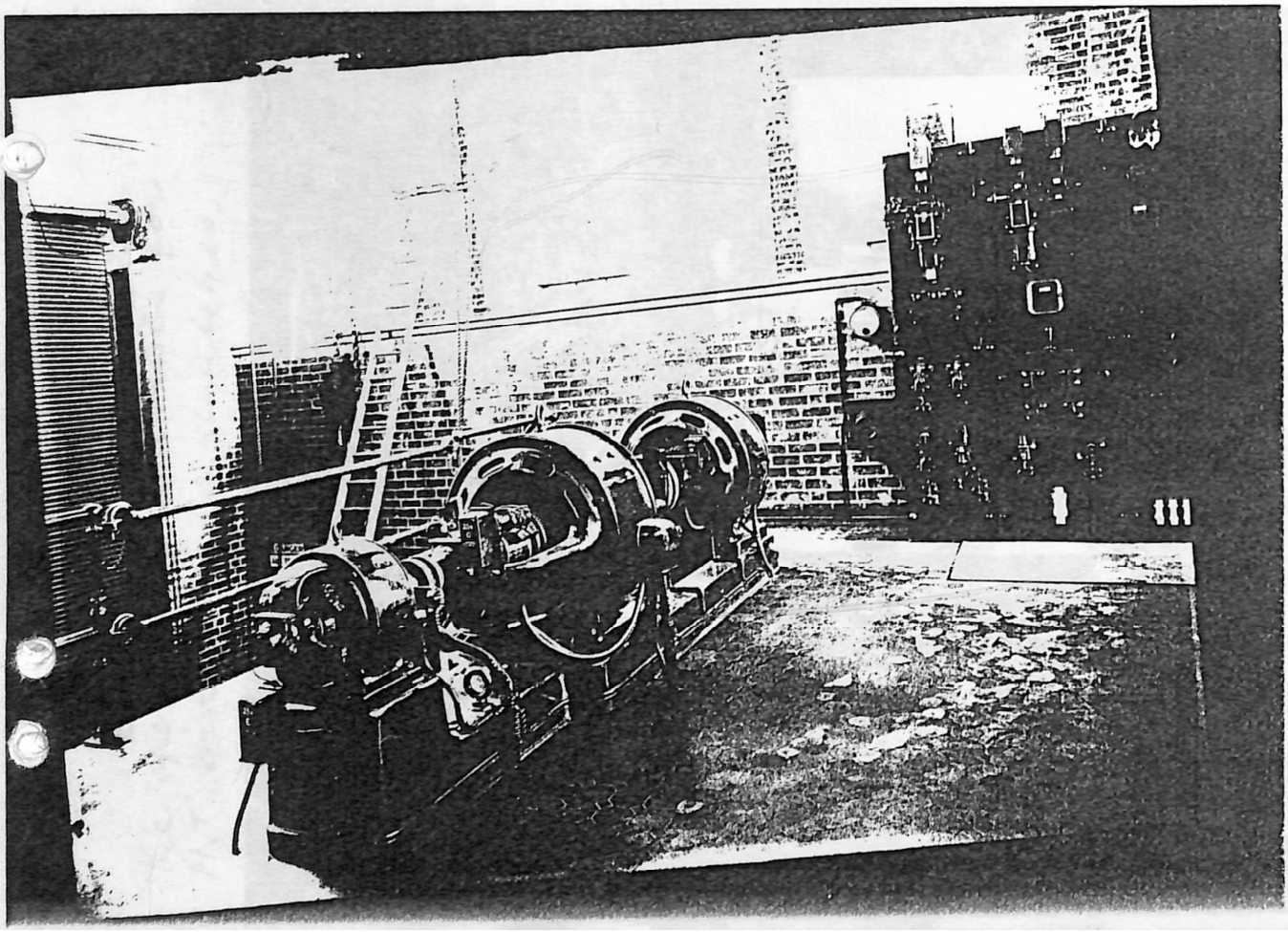


Elwood Sub-Station. Northern (e) & Western face.



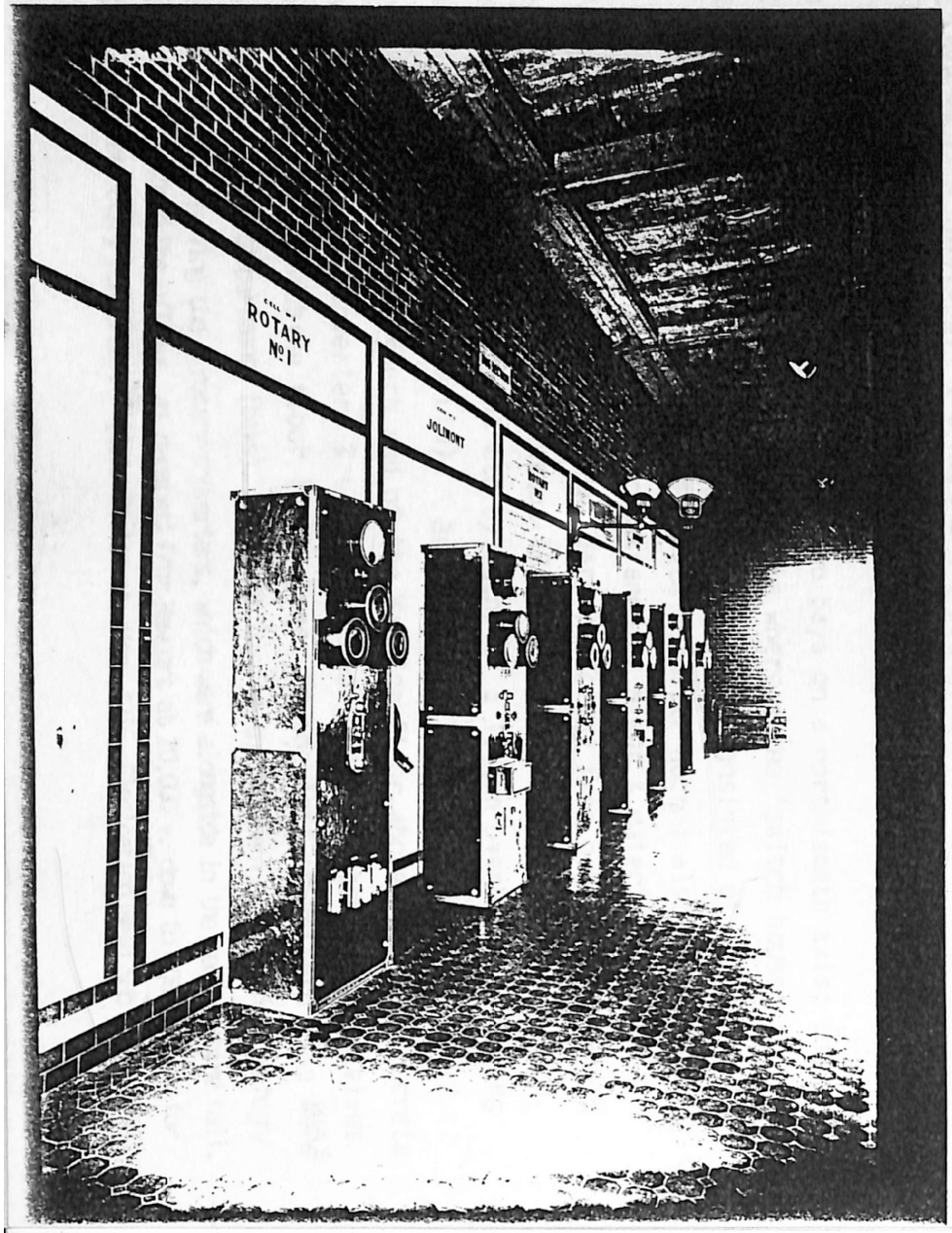


1st Elwood Substation. Nos 2 & 3 rotary converters, Pirani booster in background. Steel stairway to "Operating level". D.C. switchboard at left.

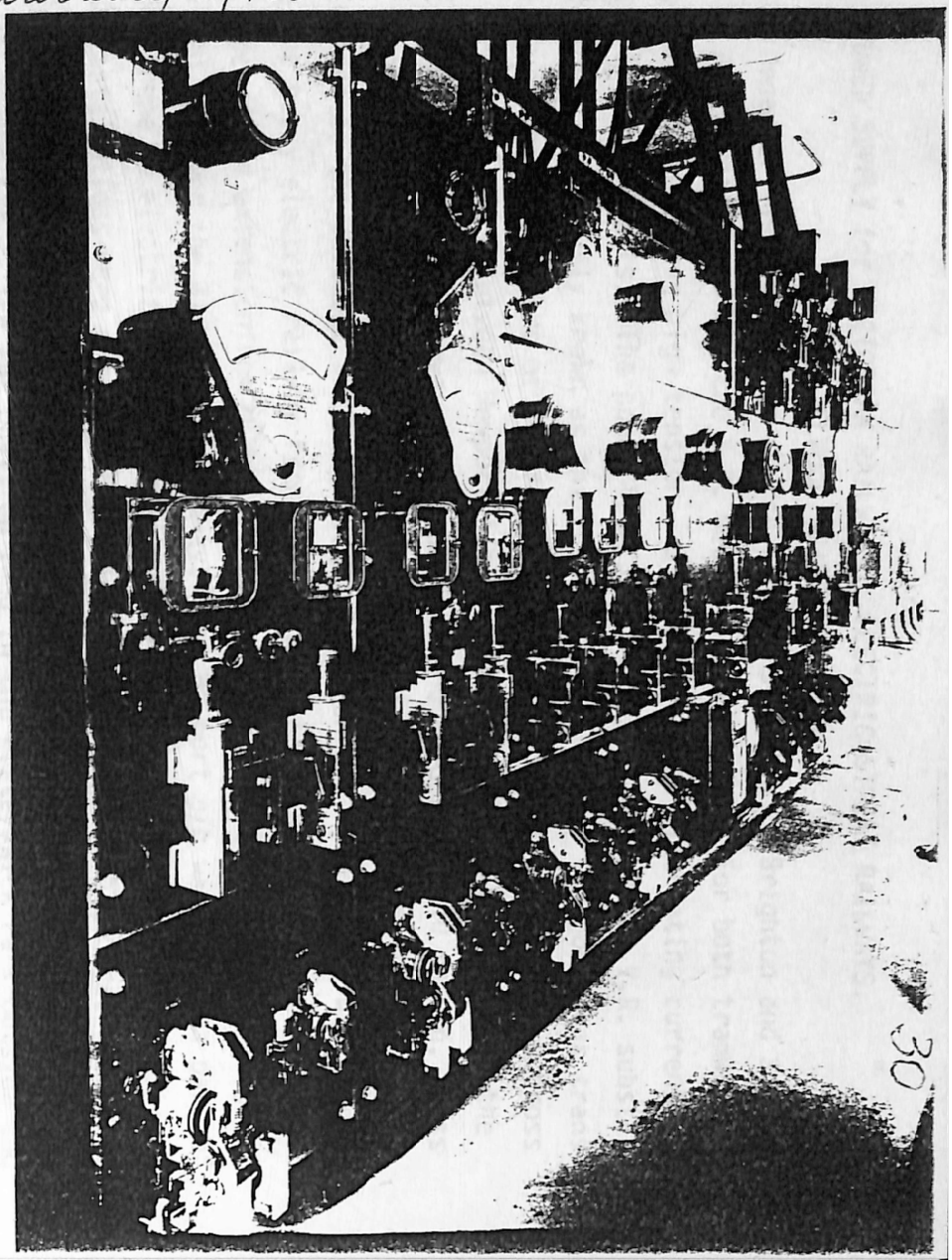


Siemens Pirani booster. The ladder is leaning against the inner brick wall of the transformer cells.

Elwood Substation
The operating controls for
H.T. oil-break switches.



Elwood Substation
The D.C. switchboard.
probably after remote control was intro.



(21)
31

POWER SUPPLY for VICTORIAN RAILWAYS ; ELECTRIC STREET RAILWAYS.
THE ELWOOD SUBSTATION.

From December, 1918 the power source for the St Kilda to Brighton and Sandringham to Black Rock trams was the V.R. Newport Power House. For both tramways the supply from Newport was high tension - 25 cycle 3 phase alternating current at a pressure of 20,000 volts. The power from Newport was by way of the V.R. substation at Jolimont (originally known as the Princes Bridge s/s). The power was transmitted via underground feeders of 3-core transmission cable of 0.15 sq. inch cross section for the distance between Newport p/h and Jolimont s/s. From Jolimont the H.T. a.c. for the Brighton tramway was by underground feeder of 0.10 sq. in. cross section to the Elwood s/s. Another parallel underground cable of 0.10 sq. in. X-section connected the Jolimont with the Middle Brighton s/s. This sub. was mainly to serve the heavy electric railway from Melbourne to Sandringham. However, a 0.10 sq. in. underground extensionfrom Midd. Brighton s/s to a small s/s at Sandringham was provided to power the Black Rock tramway. The Newport p/h was built as part of the large scheme to electrify the suburban railway system. The Elwood & Sandringham power installations were considered subsiduary schemes in the general electrification plan.

Description:- The Elwood s/s was built on land in the Elsternwick Park outside and to the east of the existing power house reserve. The building was of substantial brick & concrete construction of four levels and with a flat roof of concrete covered with malthoid. The four levels were named : 1/ Ground floor. 2/ Machine floor. 3/ Operating floor. 4/ Busbar floor. The entrance to the building faced south to Head Street. The western elevation was 70 ft. 9¼ in. long; the eastern elevation was 68 ft 1 in. long; the northern & southern elevations were 62 feet long. The height from ground floor level to the top of the roof pediment was 48 ft 11½ in.

In general the building consisted of two bays on a north/south axis; the bay or 'generating Hall' on the west side had 2 levels whereas the 'switch house' on the east side had 4 levels. The entrances at the south end consisted of a doorway 15 ft 6 in. high x 12 ft wide and provided with a roller door ; also a swing door, 2 ft 10 in. wide; the former doorway for entrance of plant & materials and the latter for personnel. Looking through the larger doorway from outside, one would see immediately ahead an open space, about 12 feet deep, clear to the roof which could be used for unloading of plant etc by means of a 10 ton overhead travelling crane (supplied by Herbert Morris Ltd). Beyond the unloading space were brick/concrete piers supporting the south end of the Machine floor above, and the concrete foundations of the rotary converters & the Pirani booster. The machines themselves were accommodated on the machine floor level above. On the left or western side ~~were~~ was a row of 5 brick open topped compartments (bays). The three bays at the northern end were for the high/tension main transformers serving the 3 rotary converters, which were alongside in the open machine hall. The main transformer reduced the H/T a.c. as received from Newport at 20,000 v. down to 408 v. a.c. for feeding to its adjacent rotary converter. (Gen. Statement, Mar. 1916- Elec'cation Melb Sub Rlys. p 56)

POWER SUPPLY for VICTORIAN RAILWAYS ELECTRIC STREET RAILWAYS.
THE ELWOOD SUBSTATION.

Ground Floor (cont.)

The two cells at the southern end housed various items of auxilliary plant ie. :- an auxilliary transformer (N° 2) of British Westinghouse make of 133 K.V.A. cap. for the purpose of reducing the 20,000 v. 3 phase, 25 cycle A.C. to a low voltage of 440 for general station usage. Such gen. usage included :-

1/ A British Westinghouse transformer which reduced the 440 v. to 110 v. for lighting purposes.

2/ A motor generator for charging the station storage battery - the motor portion was a 8.5 hp. AC induction type by Siemens Bros. The generator portion of 5 KW. produced 120/170 volts D.C. was also by Siemens Bros.

3/ An air compressor by the Anderson Foundry Coy. (?) of Anderton (?) with a capacity of 23 C.F.P.M. @ 60 P.S.I.. The motor was an induction type by Siemens.

On the eastern side of the building on the ground level of the switch-house bay was a room for the station storage battery. This room was 7 ft. 3½ in. wide x 15 ft. 2in. long. The battery was for the purpose of powering the control equipment of the s/s and was kept charged by the motor generator (see above). The remainder of this level was mainly for the foundations of the rotary machines and the oil switch cells of the switch house. The ground floor had about 7 feet head clearance with the machine floor above.

POWER SUPPLY for VICTORIAN RAILWAYS ELECTRIC STREET RAILWAYS.

THE ELWOOD SUBSTATION.

(23)
33

The Machine Floor level- Generating HALL :-

here was where the three rotary converters, and the Pirani booster were situated. The rotaries & the booster with their axes across the north/south line were situated just to the west of the building centre line. To the west of the row of machines were the tops of the main transformer bay (cell) walls which stood about 6 feet above machine floor level. In the cell walls facing the rotaries slots in the brick-work accommodated the'starting panels'which controlled the 408 volts A.C. from the transformer to the relevant rotary. The rotary converters were the machines which produced the 600 v. D.C. required to power the tramcars. The power from Newport was transmitted to the substations as A.C. because of efficiency ie. less loss of voltage over distances compared with D.C. and smaller & cheaper copper cables for A.C. transmission.

The space above the rotary machines and the transformer bays extended about 30 feet to the roof. This space was used by a travelling crane of 10 tons capacity on tracks running north/south, fixed about 22 ft. 6 in. above the machine floor.

The rotaries were numbered 1,2 & 3 from north to south; the Pirani booster was south of N° 3 rotary. In this substation the booster was used to power the negative return feeder to the Brighton end of the track to counter the voltage drop there. However, this machine was purchased ORIGINALLY ca. 1913 for use in the original Elwood steam power house to charge the traction storage battery which was part of the plant until 1919. The signifcance of the name 'Pirani' has yet to be discovered, nor has the name of the manufacturer (SIEMENS PERHAPS) come to light. The Pirani booster comprised three machines on a common bedcasting, ie. a D.C. motor driving a generator plus an exciter for the generator. Access to the machine hall floor from ground level for personnel use was by means of two flights of concrete steps - on each side of the unloading space at the entrance.

The Switch House bay at machine floor level:- The output of the rotaries (600 v. D.C.) was led to the D.C. switchboard which was on this level of the switch house bay. This switch board was beneath the overhang of the operating floor of the switch house above. This overhang formed a balcony which overlooked the machine hall. The D.C. switchboard in Dec. 1925 (V.R. E.E.Branch Drg. N° F-1436, dated 17/12/1925) consisted of 8 panels. The two panels at the north end were each provided with 1200 amp. circuit breakers. The next two panels were equipped with 600 amp. circuit breakers. These four panels fed the four feeder sections of the tram route overhead. The 2 panels with the 1200 amp. c/bs were connected to the 2 sections at the Saint Kilda end of the line. The other two panels were for the Brighton sections of line which had a lighter service. The three panels at the southern end were for the outputs of the three rotaries. The remaining panel near the centre was listed as a "leakage panel". This leakage panel took 600 v. from the D.C. busbar & via a rheostat fed a reduced voltage (530) to the Pirani booster.

POWER SUPPLY for VICTORIAN RAILWAYS ; ELECTRIC STREET RAILWAYS.
THE ELWOOD SUBSTATION.

Behind the D.C. switchboard extended a row of seven cells on a north/south axis which contained the H/T oil break switches. At Elwood the oil switch cells from north to south were labelled as under:-

Cell N° 1	a "skeleton" auxilliary transformer.
Cell N° 2	Rotary Converter N° 1.
" N° 3	H/T feeder from Jolimont substation.
" N° 4	Rotary Converter N° 2.
" N° 5	H/T feeder from Middle Brighton substation.
" N° 6	Rotary Converter N° 3.
" N° 7	Auxilliary Transformer N° 2.

Each oil switch cell had its foundations at ground level and it extended vertically up the three levels. Each cell averaged about 6 feet wide x 8 feet deep, of three brick walls and a perforated steel door which closed off the fourth side (machine floor level). The row of doors faced east to a side passage- 6 ft 6 in. wide - the length of the building. The H/T feeder cables entered the switch house from outside at ground level and were led up to the cells above (machine floor), where there were cable terminating boxes, earthing switches & potential transformers. The 20,000 volt supply was then led up to the next level to the oil break switches and current transformers. At the next level, (operating floor) the mechanisms for operating the oil switches were actuated by a row of box like control stands. These stands were backed against a brick wall. On the other side of the wall was the row of 7 oil switch cells. Each control stand was positioned so that it was opposite the switch it was controlling. The wall was finished with ceramic tiles which were labelled to designate the oil switch controlled. A steel stairway extended up from the machine floor to the operating balcony above. The east side of the oil switch cells had weather proof doors because they opened onto a gallery formed by an inset balcony open to the outside of the building.

Lastly the 20,000 volts was taken up to the next level to the bus bar chambers for distribution to the various transformers on the west side of the building.. In general this arrangement was repeated for 6 of the 7 cells. Cell N° 1, however contained only a "skeleton" for an auxilliary transformer, i.e. a basic installation which was not connected up. The oil break switch was a device for connecting or disconnecting the 20,000 volt circuits either normally by mechanical means or by operating automatically owing to overload or fault by circuit breaker action., The switch mechanism was submerged in a tank of transformer oil in order to quench the arc to minimise burning of the contacts.

Access to the next level - bus bar chambers - was provided via steel runged ladders from the operating level at the north & south end of the building. Again the row of cells imitated the format of the cells on the levels below. Doors on the cells opened onto a n/s passage on the east side of the building. At the north end of the bus bar passage was another steel ladder which led up to a trapdoor giving access to the flat concrete roof. Ventilating louvres in a clerestory, about 6 feet high x about 10 feet wide were located above the machine hall; "roof lights" were positioned over the operating floor balcony (shown on the drawing) were the features of an otherwise flat malthoid covered roof. What a marvellous vantage point it would have been from which to photograph the rear areas of the "Elwood Car Depot"!! As far as I know nobody had access to the roof for this purpose and therefore no such bird's eye photos are known to exist.

(Sheet N° 25 not utilized)

26

35

POWER SUPPLY for VICTORIAN RAILWAYS ELECTRIC STREET RAILWAYS.,
THE ELWOOD SUBSTATION.

The 600 v. D,C, supply to the tram route overhead was originally intended to be transmitted by underground feeder cable from the s/s to the track in St Kilda St. outside the Depot. Owing to W.W.1, the necessary cable was unprocurable and so as a temporary measure an overhead pole line was erected. The conductors for this line was made up from lengths of old trolley wire bound together. The output from the steam power house was joined to the s/s pole line so that either power source could be utilized during the testing & commissioning of the s/s. After the War, when industry returned to peace time production, it was decided to erect a permanent pole line rather than go underground as this arrangement obviated electrolysis problems.

In order to reduce the running costs of the E.S.R., the Commissioners decided to replace the three shifts of s/s attendants at Elwood by remotely controlling the station from the Jolimont s/s. This was achieved by the installation at Jolimont & Elwood of equipment which enabled the electrician at Jolimont to start up or shut down any or all of the rotary converters at Elwood. At Jolimont was a "remote control panel" interposing between Jolimont and the " machine control panel" at Elwood. As a necessity, instruments and devices were installed to convey information to Jolimont regarding irregularities in temperatures of machine bearings and of transformers, electrical overloads & faults, machine overspeeds and the power operation of switch gear previously manually operated at Elwood.

In addition,to the control of auxilliaries such as the booster & the motor generator, a maze of contactors, relays and coils were required to effect the remote control of the plant at Elwood. The remote control of Elwood s/s from Jolimont s/s was introduced on 26 March 1928.