

The application of the 50-cycle System as proved by System Tests

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The diagrams show examples of the results that were obtained from the System Tests made on August 10 and 11, 1960 on the Colchester-Clacton-Walton line of the Eastern Region of British Railways.

Diagram 1—Histograms of measurement of induced voltage in some Railway Signalling and Telecommunication Cables. This diagram shows histograms of measurements made during the peak load period on certain particular railway communication circuits.

The histograms on this diagram show the nature of the results obtained and are the pattern that one would expect and show that on the Colchester-Clacton line there was heavy over-insurance against the possibility of interference and that was part of the Railways' initial policy. In the result, none of the values exceeds about one-third of what is permissible. The fourth histogram on this diagram refers to the longitudinal psophometric voltage and is put in as a further example of the technique and not because the result is particularly significant.

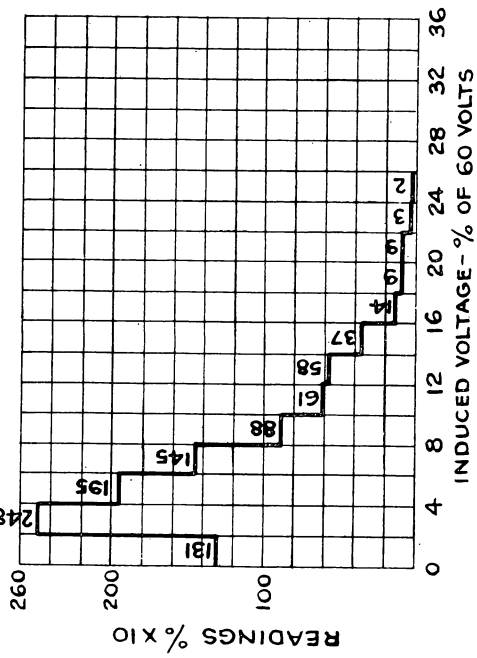
Diagram 2—Histograms of Typical Measurements on a 4-car Multiple-Unit Train. This diagram gives some particulars of what was happening on a sample motor coach unit while the measurements indicated on diagram 1 were being made on the signalling and telecommunication circuits. A great number of other measurements were made which will be reported in due course. The three histograms shown on this diagram refer to the voltage received by one of these 4-car units, to the current it was taking, and to the power consumption. Other measurements have been used to define the position of the train on the line. Every time a train passes a mile post it gives a signal, which is recorded on the train; there is also a record on the train of the speed, and by integrating the speed

against the mile post the position of the train is established. *Diagram 3*—Examples of Harmonic Analyses of line current and train current. The examples show in tabular form the harmonic analysis of the current in one of the feeders at Colchester Railway Feeder Station during the tests. These are simultaneous measurements made by the harmonic analyser, described in Paper 12, of the fundamental and 11 selected odd harmonic components—3rd to 31st inclusive—of the 50 c.p.s. current. It is felt that the novelty of this will be of interest in that it has been very difficult with previous techniques to get such information so quickly. The diagram also gives some typical values for the principal harmonics in the line current taken by one of the trains.

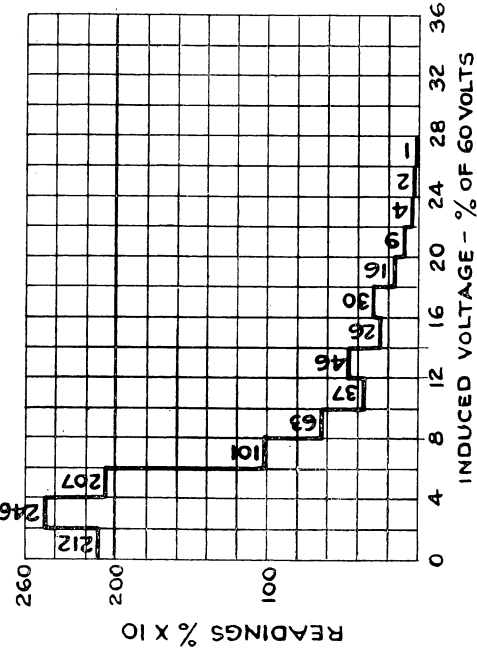
Diagram 4—Examples of Typical Related Measurements. This diagram records the state of the whole system at four particular times during the period when the main measurements forming the basis of the histograms, shown on diagrams 1 and 2, were being taken. The times chosen for the investigation of the conditions and the related events are those when the average peak values of interference shown on the histograms on diagram 1 occurred. As an example, on diagram 1 it will be found that the maximum interference on an unscreened cable lying in a trough with screened cables on the Wivenhoe to Clacton section was between 24-26% of 60 volts. On diagram 4 will be found displayed the state of the whole system relating to the time when that maximum value was being created.

The diagrams now published differ slightly from those circulated at the Conference. An improved scale has been adopted for the histograms, a minor drawing error has been corrected on diagram 4 and a note has been added to diagram 3 commenting on the accuracy of certain values.

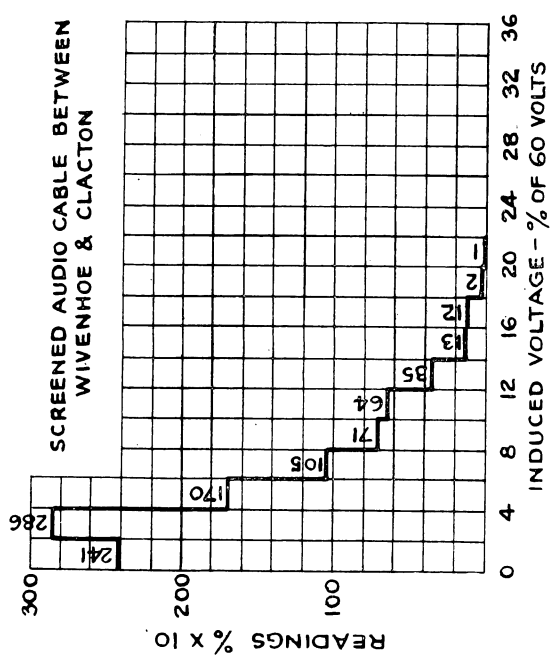
UNSCREENED SIGNALLING CABLE LYING IN A TROUGH WITH
SCREENED CABLES - WIVENHOE TO CLACTON



UNSCREENED SIGNALLING CABLE LYING IN A TROUGH WITH
SCREENED CABLES - WIVENHOE TO THORPE-LE-SOKEN



SCREENED AUDIO CABLE BETWEEN
WIVENHOE & CLACTON



SCREENED AUDIO CABLE BETWEEN
WIVENHOE & THORPE-LE-SOKEN

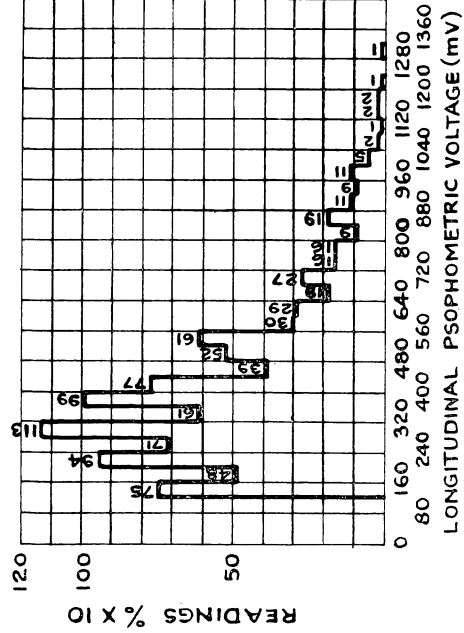


Diagram 1 Railway Signalling and Telecommunication measurements
Test Period 10/8/60 12-30 p.m.—1.30 p.m. Histograms

Diagram 2 Electric train equipment measurements for one 4-Car Multiple-Unit
 Test period 10/8/60 12.30 p.m.—1.30 p.m. **Histograms**

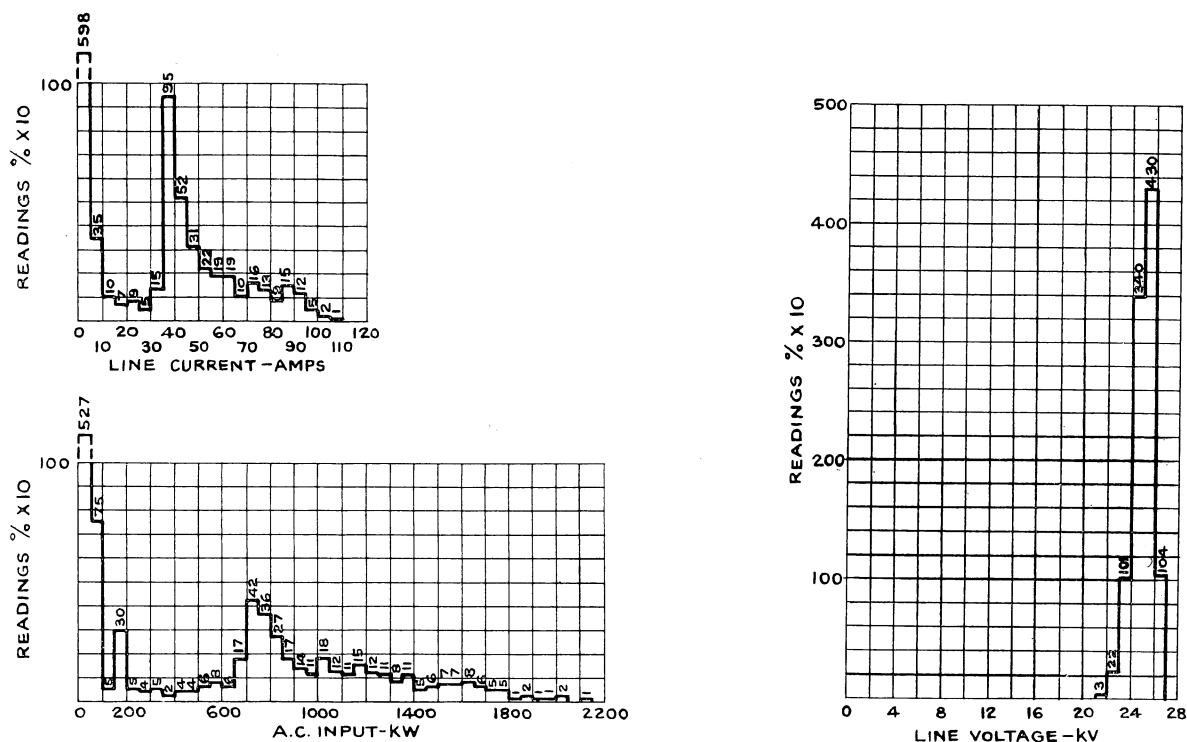


Diagram 3 System Tests Colchester - Clacton - Walton Line

A. Overhead Contact System—Current in Down Line feeder at Colchester Railway Feeder Station

Harmonics

Line Current	Test Time & Date			
	10th August 1960			
	12-37-40/42	12-37-52/54	12-43-04/06	12-45-30/32
	Amps. 95	Amps. 100	Amps. 155	Amps. 194
Harmonic %	%	%	%	%
Fundamental	100	100	100	100
3rd	12.45	13.30	12.50	9.69
5	4.69	4.47	4.22	1.63
7	3.38	3.16	3.42	1.05
9	2.66	2.31	2.16	1.03
11	3.49	1.78	1.32	1.76
13	0.15	0.12	0.31	0.14
15	0.07	0.09	0.09	0.02
19	0.06	0.05	0.07	0.03
23	0.06	0.24	0.13	0.02
27	0.09	0.15	0.09	0.04
31	0.05	0.07	0.06	0.00

Note: " The sensitivity adopted for measurements was such that the 13th and higher harmonics have probably been under-estimated on this test "

B. Typical line current harmonics for an Electric Multiple Unit

R.M.S. Line Current	Amps. 39	Amps. 82
R.M.S. Harmonic %	%	%
Fundamental	100	100
3	17	15
5	9	7
7	6	4
9	3	2

