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A Multi-Channel V.F. Telegraph System for Héll-Schreiber Signals

Carried out by: A. Cook, L.T. Amman, P.R. Hutton-Ferrier and S.W. Bliss.

W. West
Assistant Staff Engineer

A.H. Mirmord
for Engineer-in-Chief.

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Office of the Engineer-in-Chief,
(Radio Branch),
General Post Office,

Summary

This report describes a multi-channel V.F. Telegraph system developed for operating at a sufficiently high-speed for use with the Héll-Schreiber system of transmission. At the present time there is only use for one such system and this operates between Reuter's Office in London and Leafield Radio Station; to meet this specific case three unidirectional high-speed channels together with a low-speed two-way order-wire have been provided for operation over a two-wire land-line circuit.

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Drawings /
1. **INTRODUCTION**

Holl-Schreiber signals involve signalling speeds of 245 bauds for 7-line working and 540 bauds for 12-line working; these speeds are too high for passing over long physical lines using DC keying or over the P.O. standard 18-channel voice frequency telegraph systems. Thus to provide a single transmitter control circuit between Reuter's office in Fleet Street and Leafield Radio Station simple arrangements were made to key a carrier frequency of 900 c/s and to transmit the signals over a physical circuit to Leafield where they were converted to DC pulses by a thermionic relay. This arrangement was modified in 1940 when it became necessary to arrange for keying facilities for the one Holl-Schreiber transmission from Messrs. Reuter's office in Barnet. The arrangement then adopted was effectively a multichannel V.F. system giving facilities for operating two Holl-Schreiber channels plus a breathy Morse orderwire on one physical line. In use, one Holl-Schreiber channel was scheduled as a working channel and one as a spare channel although both could be operated independently.

In 1942 Reuter's found it desirable to operate this service from Fleet Street again whilst still maintaining facilities at Barnet as a reserve. Further equipment provision was therefore necessary. By this time the Holl-Schreiber system of discriminating press news had come to be regarded as of increasing importance and Messrs. Reuter's envisaged the extension of the system to most or all of their radio services at present operated on a Morse basis. Thus it was decided that it would be economical to design specially a multichannel V.F. system for Holl-Schreiber signals. Accordingly a system has been developed and the design has been governed by the desirability of using carrier frequencies which are already standard for the inland telegraph network and of not exceeding the bandwidth required for a standard 18-channel V.F. system.

The system described in this Report provides 3 unidirectional wideband (600 c/s) channels for Holl-Schreiber signals and one channel in each direction having a bandwidth of 120 c/s for use as a Morse order wire.

Two transmitting terminals have been installed in Reuter's office in Fleet Street and one at their emergency office in the Greater London area. A complementary receiving terminal has been installed at Leafield for normal use and a set of receiving filters at Rugby; these, in association with existing thermionic relays would enable service to be given from Rugby Radio Station at short notice if required.

2. **GENERAL**

The standard type of 18-channel V.F. Telegraph system uses the frequency spectrum of 360-2520 c/s and has the carrier-frequencies uniformly distributed at intervals of 120 c/s, commencing with the frequency of 420 c/s: it is intended primarily for operation of Teletypewriters at a speed of 66 bauds. In the case of the Holl-Schreiber transmissions the keying speed is either 245 or 540 bauds; the latter is seldom used now and is being discontinued. However, whilst the system described in this report was designed primarily for the lower speed, experiments showed that satisfactory operation at the higher speed also could be obtained. The system operates Thermionic Relays installed at Leafield for keying radio transmitters.
In considering the design of the V.F. system for Hell-Schreiber working the governing factors were:

(a) Selection of the carrier-frequencies from amongst those used on standard V.F. systems.

(b) A band-width sufficiently wide to ensure a satisfactory performance on the part of the Thermionic Relay over an adequate range of signal amplitudes.

(c) Restriction of the total frequency spectrum used to that occupied by a standard 18-channel system.

(d) The use of carrier frequencies sufficiently high compared with the keying frequency to ensure that the Thermionic Relay cannot produce a keying response at the carrier frequency.

The above conditions are met by the system described in this report which provides three one-way channels, each having a band-width of 600 c/s, and carrier-frequencies of 900 c/s, 1,500 c/s and 2,100 c/s. The frequency range thus covered is 600 c/s to 2,100 c/s leaving frequencies below 600 available for a low-speed both-way circuit for order-wire purposes. The carrier frequencies for the two order-wire channels are chosen to be the two lowest channels on a standard system, namely 420 and 540 c/s; the former being chosen for the channel operating in the same direction as the high-speed channels. The characteristics of the filters, shown on Drawing WL 19135 and WL 19136, illustrate the manner in which the available frequency spectrum is used.

3. DESCRIPTION OF CIRCUITS

3.1 Transmitting Terminal.

The overall system as operated on a two-wire line is shown in schematic form on Drawing WL 19132 and the circuit details of the transmitting terminal on Drawing WL 19133. Referring to the latter, each transmitting channel comprises an oscillator, static relay and filter, the outputs being connected to a common transmitting amplifier and subsequently passed to line via a hybrid coil Y, which functions as a combining unit for the four-wire and two-wire sides of the circuit. The tones from the oscillators are suppressed in the idle condition by means of the application of a d.c. voltage, having negative polarity with respect to earth, to the Static Relays, signalling being affected by a reversal of the polarity of that voltage.

The Hell-Schreiber transmitters normally operate on a single-current basis, and so, in order to convert to double-current operation (so as to introduce sufficient attenuation in the Static Relay in the idle condition), the negative battery is applied through resistor R, the value of which is so chosen that sufficient current flows through the Static Relay from the positive battery when the contact is closed. Switching relays are provided in the d.c. control circuits to facilitate changeovers between Morse and Hell-Schreiber operation.

Hybrid X gives facilities for the paralleling of channels from similar equipment, installed at an emergency point, to enable operating from both offices on the one land-line. Such a procedure, however, would preclude the simultaneous use of channels having the same carrier frequencies from both offices.

The receiving channel, CH.5, is terminated in this particular instance in a loud-speaker for the reception of Morse signals for order-wire purposes.

Arrangements are also shown on Drawing WL 19133 for the monitoring of the tone-signals on any one of the channels as required. The auxiliary monitoring equipment comprises an amplifier, loud-speaker, and Hell-Printer; for Morse signals the amplifier and loud-speaker are used, but for Hell-Schreiber signals the amplifier is connected to the printer; in both cases the amplifier, which has a high Rota 1252 W/4.
impedance input, is directly connected to the appropriate V.F. monitoring point.

3.2 RECEIVING TERMINAL, LEAFIELD

The circuit is shown in schematic form on Drawing WL 19132 and in detail on Drawing WL 19134.

Each incoming channel is segregated by means of filters, the outputs from which are then amplified and passed to Thermionic Relays. These units, in effect, are d.c. amplifiers (with a rectifying circuit at the input to convert the V.F. tone to a d.c. voltage) having a "trigger" action, the comparatively large d.c. voltage produced at the output being used to control a radio transmitter. Channel 1, the receiving order-wire, however, is an exception in this respect as the outputs of the Thermionic Relays, of which two are provided, are arranged to operate mechanical relays for signalling on a buzzer at two control positions. Channel No. 5 is similar in arrangement to the transmitting terminals described in 3.1 above. Channel 2 is provided with two outputs to cater for the emission of one service from two transmitters simultaneously, thus saving one control channel.

4. PERFORMANCE

The noise level measured on the output of one channel when all other channels are being operated simultaneously is of the order of 35 db below the level of the tone received under marking conditions. At the sensitivity of the receiving unit (Thermionic Relay) is only 17 db below the marking tone there is a large margin against false operation by other channels.

Actual distortion measurements have not been made, but on operating a Hell-printer from the output of a Thermionic Relay good printing was obtained over a range of 15 db on both the 7- and 12-line systems. As indicated on Drawing WL 19132, the normal marking tone input to the Thermionic Relay is +10 db relative to 1 mW. The maximum permissible input is +15 db relative to 1 mW; therefore the available range of amplitudes which can be tolerated at the input to the Thermionic Valve Relay is from +15 db to 0 db relative to 1 mW.

5. CONCLUSIONS

The station described provides three channels for 7- or 12-line Bell-Schreiber transmissions, together with one both-way order-wire. It has ample margin in respect of freedom from false operation by keying products from other channels in the system, and also from the aspect of level variations likely to be met with in practice. It is suitable for connection to any 2-wire, or 4-wire, circuit that has been lined-up to cater for an 18-channel standard type of V.F. Tg. systm.

APPENDIX: EQUIPMENT DETAILS

Oscillators. The details are shown on Drawing WL 17234/0 and the principle of operation is detailed in E.I., TRANSMISSION, Telephone, F 1301. Each oscillator is capable of supplying four outputs at a power of one milliwatt.

Static Relays. A complete description is given in Radio Report No. 783. Type MK II is used in the transmitting terminal equipment, but at Leafield the practice is to use a simple earth connection for signalling, as indicated on Drawing WL 19132.

Amplifiers. The circuit details for those used on the transmitting terminal equipment are shown on Drawing WL 18286/8; either of Drawings WL 18286/8 or WL 173728 refer to Leafield.

Rota 1252 W/44

Power Supplies
Power Supplies. The whole of the equipment is designed for use with suitable units operating directly from 200-250 volt a.c. supplies. Diagrams WL 18225A and WL 18222 refer to the power units.

Amplifier - Loud-Speaker Units.

The details are shown on Drawing WL 19140. This unit has a high-gain and arrangements are made for choice of an input impedance of either 600 or 20,000 ohms. The output of the amplifier is normally connected to the loud-speaker, which can handle a power of 2 watts, but a secondary output having an impedance of approximately 600 ohms is also provided.

Filters. The design and the construction of the filters follow closely the methods described in TELEGRAPHS, Multi-Channel V.F., A1020, the impedances between which the filters are designed to be connected being the same (600 ohms), and the design band-width also the same (120 cps.) for channels 1 and 5, but wider (550 cps.) for channels 2, 3 and 4. Drawing WL 19137 shows details of the design for all five channels, and Drawings WL 19135 and 19136 show performance curves which have been obtained with the filters terminated by non-reactive impedance of 600 ohms. The attenuation networks which have been inserted at the input of the transmitting filters and at the output of the receiving filters serve to standardise the insertion loss at 4 dB and 6 dB respectively. In all cases the unbalanced side of the filters is connected to earth.

Physical Details. The transmitting terminals are mounted on a standard rack of 6'16" in height as shown on Drawing WL 19139 (not attached); the units projecting 8" from the rack on each side.

At Leafield the equipment also occupies both sides of a 6'16" rack, Drawing WL 18225A (not attached) refers.
HIGH SPEED M.C. V.F. TG. SYSTEM.
FOR HELL-SCHREIBER OPERATION.

TRANSMITTING FILTERS.

WL 30132

Frequency, c/s.

Insertion Loss in db.
HIGH SPEED M.C.V.F. TG. SYSTEM
FOR HELL-SCHREIBER OPERATION,
RECEIVING FILTERS.

FREQUENCY, 46.
MULTI-CHANNEL HIGH SPEED V.F. TG. SYSTEM FOR HELL-SCHREIBER OPERATION.
TRANS. AND REC. FILTERS.
WL 19137.