MANCINO

THE INSTITUTE OF RADIO ENGINEERS
INCORPORATED

PROFESSIONAL GROUP CORRESPONDENCE
14 March 1960

PLEASE ADDRESS
REPLY TO
R. T. Haviland
Mail Station 1A36
Sperry Gyroscope Co.
Great Neck, New York

File: IRE
Subject: Abbreviation

Hazeltine Research Corporation
59-25 Little Neck Parkway
Little Neck 62, New York

Attention: Mr. R. J. Farber

Dear Mr. Farber:

1. This is in reply to your letter of 3 March 1960 regarding the abbreviation "dbmc" for "decibels above 1 microvolt per megacycle bandwidth".

2. As you probably know, there is no abbreviation for this term in IRE, ASA or MIL standards. Your abbreviation might be interpreted to mean "decibels referred to 1 megacycle" though this, generally speaking, would not make too much sense.

3. It would seem that if you define your abbreviation the first time you use it, there will be no objection to its use.

Very truly yours,

R. T. Haviland

R. T. Haviland, Chairman
IRE Symbols Committee

RTH:mds

AIR SERVICES
TELECOMMUNICATIONS ~~Branch~~
and Electronics Branch

REFER TO FILE NUMBER
5300-7

CANADA

DEPARTMENT OF TRANSPORT

Ottawa, Ontario,
June 6, 1960.

Dear Mr. Farber:

Thank you for the copy of I.R.E. 27.7 Draft 4/11/60 and copy of Dr. Showers' letter of March 29, 1960. As I will be unable to attend the meeting on June 8, 1960, I would like to submit a comment on these documents.

Enclosed is a copy of an excerpt from an article entitled, "Ignition Interference at Frequencies below 100 Mc/s", by G.F. Newell, published in the British Broadcasting Corporation Quarterly, Vol.9, No.3, 1954. Unfortunately, the enclosure is a photo copy of a photo copy, and some of the detail is lost. However, in Figure 3 the long train of impulses can still be seen fairly well.

The point I wished to bring up is that a typical ignition spark is not a single shot but more like a machine-gun burst, the burst often having a duration of a millisecond or more, with a spacing between pulses of perhaps 10 microseconds; that is, a separate spark discharge every 10 microseconds or so.

Paragraph 2 of Draft 4/11/60 states that vehicular radio noise is impulsive in nature and of sufficiently low repetition rate so that the i-f transients set up in receivers of bandwidths typical of mobile communication equipment are substantially non-overlapping. This appears to state that there is only a single impulse involved; likewise, while Dr. Showers' definition of Spectral Density does point out that it is applicable only to a single impulse, the context in which it stands rather implies that it is applicable to typical ignition noise.

Mr. Richard J. Farber,
Hazeltean Research Corporation,
Little Neck,
New York,
U.S.A.

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In typical ignition noise, while the initial pulse of the train is perhaps four or five times the amplitude of the succeeding pulses, the fact that there may be 100 or so of these successive pulses would indicate that their energy content would dominate the picture.

I would therefore suggest that the Committee consider amending the Draft to eliminate what appears to be an incorrect statement or inference of fact.

Yours very truly,

L. E. Coffey.

Encl: L.E. Coffey.

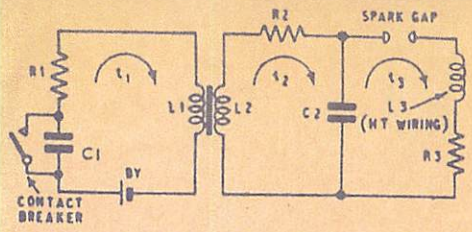

Fig. 1(a). Simplified circuit of ignition system

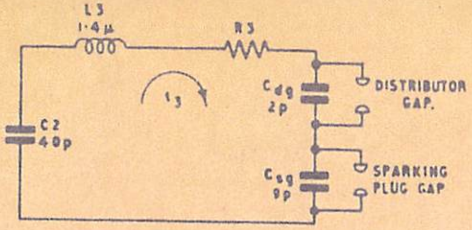

Fig. 1(b). More detailed circuit of spark gap

In 1949, Pressey and Ashwell[4] published measurements of the field strength of interference between 40 and 650 Mc/s; this was found to be sensibly uniform over the frequency band. A theory of ignition interference was published by Nethercot[5] in 1949; he deduced that the spark current consists of a damped oscillation, of frequency between 30 and 50 Mc/s, modulated by a sawtooth waveform having a repetition frequency of some 300 Mc/s associated with successive reflections in the ignition system.

In the next section a new approach to the problem is described in an attempt to explain how the characteristic train of pulses is produced, and to calculate the resulting spectrum.

Theoretical Considerations

The Basic Circuit

An ignition system can be approximately represented by the circuit of Fig. 1(a). The condenser C_1 represents the fixed capacitance across the contact breaker; R_1 and L_1 are the series resistance and inductance respectively of the primary winding. R_2, L_2 and C_2 are the secondary resistance, inductance and self-capacitance respectively. L_3 and R_3 represent the series inductance and resistance of the sparking plug leads; R_3 includes the equivalent series resistance of C_2, which is of importance when C_2 is discharging through the sparking plug circuit.

Initially the contact breaker is closed, permitting a direct current to flow from the battery through the primary circuit. Let us assume that this current has existed for a sufficiently long time to have become substantially constant at a value determined by the battery voltage and the primary circuit resistance. The contact breaker now opens and the resulting change in the primary current produces a voltage across C_2.

If the sparking plug were disconnected, the voltage across C_2 would consist of two superimposed damped oscillations with frequencies and decrements determined by the constants of the primary and secondary circuits. A photograph of this waveform is shown in Fig. 2(a). If, however, the sparking plug circuit is connected, the voltage across C_2 increases to a value sufficient to break down the spark gap, with the distributor gap in series; C2 is then rapidly discharged. It is this discharge current in which we are vitally interested as it is the cause of the interference.

The condenser C_2 continues to discharge until the spark is quenched; the secondary current continues to flow, thus recharging C_2. The gap breaks down a second time at a lower voltage due to residual ionisation of the cylinder gases, and the cycle continues until the current flowing in the secondary circuit is insufficient to charge C_2 up to the gap breakdown voltage. It is also possible that the build-up of pressure in the cylinder when the gas ignites may be sufficiently rapid to terminate the train of sparks. The duration of the train is certainly variable even with the same plug and circuit in any one engine.

Fig. 3 is a photograph of the sparking plug current waveform due to a single spark recorded on an oscilloscope having a bandwidth of 5 Mc/s. It consists of a series of damped oscillations; the first impulse is larger than the following ones, which are fairly uniform in amplitude. These impulses are lengthened due to the limited bandwidth of the oscilloscope, but not to a greater extent than in a television receiver. As we are concerned mainly with the effect of interference on a television receiver the important parameter is the peak amplitude of the first impulse.

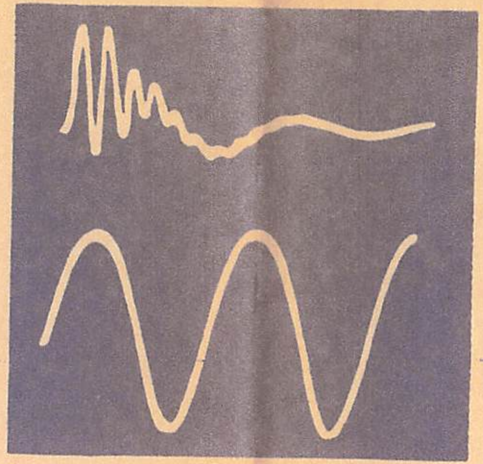

Fig. 2(a). Photograph of voltage waveform across secondary of ignition coil with sparking plugs disconnected. The lower trace is of a 2 kc/s timing waveform

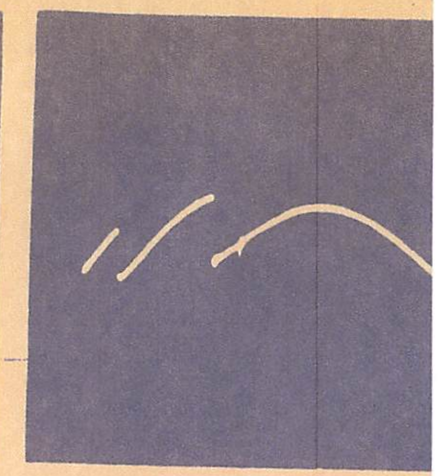

Fig. 2(b). Initial portion of voltage wav across primary circuit. Time base length ms.

The Spark Current

The circuit of Fig. 1(b) represents the sparking plug and distributor gaps, each with its shunt capacitance, connected to the secondary of the ignition circuit. As the current flowing in the ignition coil secondary charges up C_2, the voltage across the two gaps in series will be substantially equal to that across C_2; the total voltage will be distributed unequally because the capacitance across the distributor is only about 2 μμF whilst the capacitance across the sparking plug gap, including that due to the ignition lead, is approximately 9 μμF. The leakage resistances across the two gaps are usually extremely high under normal conditions, but again the resistance across the sparking plug gap is usually lower than that across the distributor gap.

As a result, initially the greater pa the voltage will be developed acros distributor gap. When the voltage a the two gaps in series reaches about kV, *i.e.*, 2·5 kV across the distributor the latter breaks down and a surge of rent flows until the voltage across sparking plug gap is sufficient to s over; C_2 then discharges through the gaps in series with L_3 and R_3. This

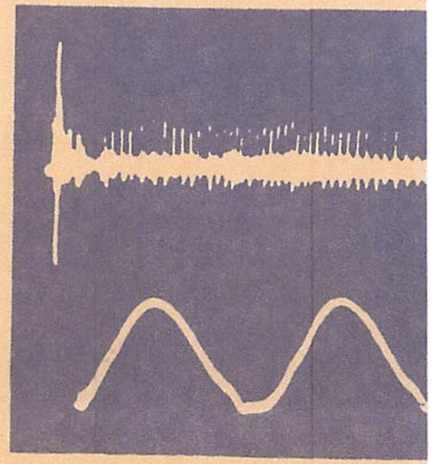

Fig. 3. Spark current waveform. The lower c is a 20 kc/s timing waveform. Bandwidt oscilloscope 5 Mc/s