Feb. 8, 1949. H. E. KALLMANN 2,461,061

EQUALIZED DELAY LINE

Filed Feb. 7, 1946

FIG. 2

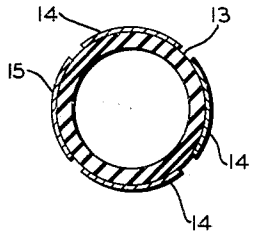
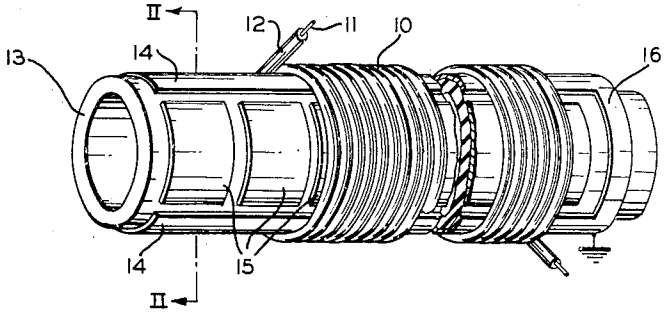



FIG. 1




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## EQUALIZED DELAY LINE

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6 Claims. (Cl. 178—44)

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This invention relates to artificial transmission lines and more specifically to artificial transmission lines of the distributed parameter type compensated for uniform response over a wide range of frequencies.

Artificial transmission lines, called delay lines, are used in high frequency transmission and signalling systems when it is desired to delay a signal or pulse for a predetermined interval of time. The proper transmission of a pulse through the delay line depends upon the ability of the line to transmit a large range of frequencies with equal attenuation and equal time of delay. A delay line of the distributed parameter type is described and illustrated in copending patent application S. N. 496,139, filed July 26, 1943, by Richard B. Nelson, Patent No. 2,420,559, issued May 13, 1947, and entitled Artificial transmission line. In a delay line of this type, the time of delay is proportional to the inductance of the winding and the capacity between the winding and ground. The capacity between the winding and ground is substantially independent of frequency, but the inductance of the winding decreases with increasing frequency. This effect is evidenced in a reduced time of delay for the higher frequencies, causing distortion of the transmitted signal or pulse.

A primary object of the present invention is to provide an improved delay line of the distributed parameter type by compensating for the above mentioned difficulty.

An additional object is to provide a means for equalizing the time delay of a delay line over the whole video frequency range.

A further object is to provide a compensated delay line providing uniform time delay of signals over the whole video frequency range.

The invention itself, together with the method of operation and advantages thereof may best be understood from the following description when taken with the accompanying drawings, in which:

Fig. 1 shows a view of a delay line embodying this invention; and

Fig. 2 shows a transverse section of the delay line along the line II—II in Fig. 1.

Referring to the accompanying drawing, a delay line of the distributed parameter type is shown. The delay line consists of a helical coil 10 formed by a conductor 11 with suitable insulation 12 thereon. The coil 10 is wound over a supporting form 13 of substantially cylindrical shape and composed of a suitable dielectric material. While coil 10 is shown covering only part

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of the length of form 13 for clarity, it is to be understood that coil 10 extends substantially the full length of form 13. Between coil 10 and form 13 is a layer of narrow conducting strips 14. The strips 14 are parallel to the axis of coil 10 and are electrically separated throughout their length, except at the transverse portion 16 where they are brought together and grounded. Also between coil 10 and form 13 is a series of patches 15. The patches 15 are formed of conducting material electrically separated from the conductor 11, strips 14, and each from the other patches 15.

The terminals of the delay line are formed by the two ends of conductor 11 and the grounded strips 14. In operation a signal or pulse is applied between one end of conductor 11 and ground and appears between the other end of conductor 11 and ground at a later time. This difference in time between the applied signal and output signal is called the delay time. The delay time is proportional to the inductance of the coil 10 and the capacity between the conductors 11 of coil 10 and the grounded conducting strips 14. The delay of a signal should depend only upon these two reactive parameters, the inductance and ground capacity per unit length. However, the delay also depends upon the mutual inductance between any two parts of the coil 10. The mutual inductance decreases with increasing frequency, because with increasing frequency the current, and hence the magnetic field of distant, yet magnetically linked turns, becomes more and more out of phase. Thus, the magnetic fields being more out of phase, distant turns contribute less to each others fields. This effect is compensated for by capacitors which bridge the delay line to link distant turns. To provide such linking the patches 15 are capacitively coupled to groups of turns forming the bridging capacitors. As the magnetic fields of the turns bridged by patches 15 become more out of phase with increasing frequency, the effect of the bridging capacity increases. This effect increases until the field of the turns linked become 180° out of phase.

The length of the patches 15 determines the maximum frequency of compensation. The degree of compensation provided depends upon the bridging capacity provided by the patches. The width of the patches, also the thickness and dielectric constant of the insulation between them and the coiled conductor, serve to control the amount of bridge capacity provided. The desired isochronism, or other delay characteristic, can be

adjusted by choice of the two parameters the length and width of each patch. Staggering, random, or periodical change of patch size may also be used.

In construction of the delay line, the form 13 may be composed of glass, porcelain, or a plastic insulating material such as polyvynlidene chloride also known as Saran. The conducting strips 14 and the patches 15 may be thin sheets of conducting material such as copper or silver placed on the surface of form 13 before winding coil 10, or the strips 14 and patches 15 may be formed by a plating of copper or silver on the surface of the form 13. The conductor 11, preferably copper, may be covered with insulation 12 suitable to withstand the voltage for which the line may be used, or the insulation 12 may be enamel having a low voltage rating and a layer of high voltage insulation placed between the coil 10 and the strips 14.

It is understood that this invention is not limited to the details of construction illustrated in the accompanying drawing and described above, except as appears hereafter in the claims.

What is claimed is:

1. Compensation for a delay line of the distributed parameter type, said delay line including a helical coil of a conductor and means for providing distributed capacity between said coil and ground, said compensation comprising a plurality of insulatively mounted conducting patches, said patches capacitively coupling a number of turns of said coil of said delay line.

2. A delay line comprising, a helical coil of an insulated conductor surrounding a number of conducting strips parallel to the axis of said coil, said strips being conductively coupled at one point, a plurality of conducting patches insulatively mounted, said patches being capacitively coupled to said coil.



3. A delay line comprising, a substantially cylindrical core of insulating material having on its surface a number of conducting strips, said strips being parallel to the axis of said core, and being conductively coupled at one point forming one terminal of said delay line, a conductor, suitably insulated, forming a helical coil surrounding said core and strips, a plurality of conducting patches insulatively mounted and forming capacitive coupling between distant turns of said coil.

4. A delay line of the distributed parameter type comprising, a substantially cylindrical core of insulating material, a plurality of conducting strips on the surface of said core, said strips being substantially parallel to the axis of said core, said strips being insulated except at one point where said strips are conductively coupled, a plurality of conducting patches on the surface of said core, said patches being insulatively mounted, a winding of an insulated conductor forming a helical coil surrounding said core, strips, and patches.

5. A frequency compensated delay line of the distributed parameter type, said delay line including a helical coil of a conductor, a conductive member disposed in spaced relationship to said coil providing distributed capacitance between said coil and said conductive member, and a plurality of insulatedly mounted conducting patches, said patches capacitively coupling a number of turns of said coil of said delay line.

6. A frequency compensated delay line of the distributed parameter type, said delay line including a helical coil of a conductor, means providing distributed capacitance between said coil and ground, and a plurality of insulatedly mounted conducting patches, said patches capacitively coupling non-adjacent turns of said coil of said delay line.

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No reference cited.