

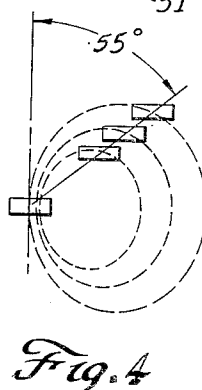
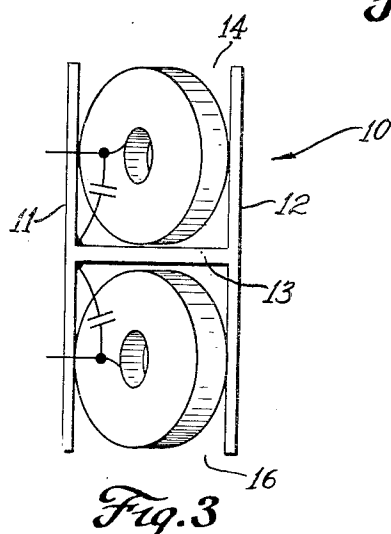
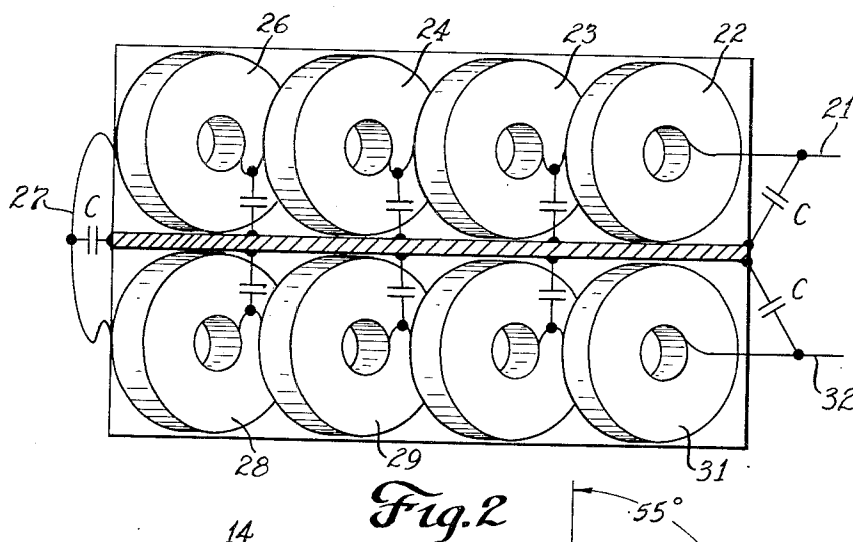
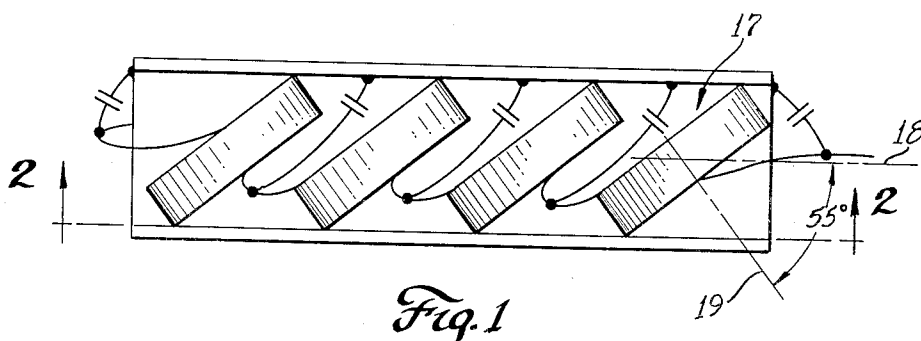
March 11, 1952

N. W. HANCOCK ET AL

2,589,076

FOLDED DELAY LINE

Filed June 9, 1950



INVENTOR.
DAVID O. MCCOY
NOEL W. HANCOCK

Marvin Moody
att.

UNITED STATES PATENT OFFICE

2,589,076

FOLDED DELAY LINE

Noel W. Hancock and David O. McCoy, Cedar Rapids, Iowa, assignors to Collins Radio Company, Cedar Rapids, Iowa, a corporation of Iowa

Application June 9, 1950, Serial No. 167,188

2 Claims. (Cl. 178-44)

1

This invention relates in general to delay lines and in particular to an assembled delay line which may have sections added thereto in a manner such that the resultant delay may be predetermined.

Where pulsed techniques are being used as, for example, in radar, it is oftentimes desirable to delay a pulse a predetermined time after another pulse. Inductance-capacitance networks form satisfactory delay circuits and have long been used. It is oftentimes desirable to connect a plurality of inductances and capacitances in a tandem. If the inductances are in the form of coils and the coils are connected so that there is mutual flux between them, the total inductance and therefore, the total delay time of the assembly will not be equal to the sum of the delay times of the individual sections. The reason for this is that the mutual inductance between coils will change the assembled inductance. Mutual inductance may be decreased by separating the coils a relatively long distance but this is generally not feasible because of spatial limitations in a radar chassis.

It is an object of this invention, therefore, to provide an assembly of delay sections in such a manner that the assembly will have a total delay equal to the sum of the delays in the individual sections.

Another object of this invention is to provide a delay line comprising a plurality of inductive-capacitive sections wherein mutual inductance is minimized even though the units are closely spaced.

Another object of this invention is to provide a delay line assembly wherein the line may be bent back upon itself in a manner such as not to form a discontinuity at the place of bending.

Still another object of this invention is to provide a compact and easily assembled delay line. Further objects, features, and advantages of this invention will become apparent from the following description and claims when read in view of the drawings, in which:

Figure 1 is a top plan view of the assembled delay line of this invention;

Figure 2 is a sectional view taken on line 2-2 of Figure 1 of this invention;

Figure 3 is an end view of the delay line of this invention; and

Figure 4 is a diagram of the flux distribution of the coils.

Referring to Figure 3, an assembled frame 10 comprising side walls 11 and 12, respectively, are joined together by a transverse member 13 to form

2

an H. An upper receiving opening 14 and a lower receiving opening 16 are thus formed. Mounted within the upper opening 14 are a plurality of coils 17. The coils 17 are formed of low resistance wire.

The coils 17 are mounted in the frame 10 so that the longitudinal axis of the frame 10 makes an angle of 55 degrees with the axis of the coil. This is shown in Figure 1 wherein the longitudinal axis of the frame is designated as 18 and the axis of the coil is designated as 19. The coils 17 are fastened to the walls 11 and 12 of the frame 10 by a suitable mounting bracket. It is to be understood that the coils are insulated from the holding brackets as, for example, by using insulated wire in the coil. The output lead of each coil is connected to the input lead of a succeeding coil and a condenser C is connected between the inputs to each coil and the frame 10. The frame may be made of conducting material as, for example, copper. An input lead 21 is connected to the first coil 22 and so on through coils 23, 24, and 26. The output lead 27 from coil 26 connects to the input lead of coil 28 which is mounted in the lower holding space 16. The lead from coil 28 is connected to the coil 29 and so on until the output coil 31 is reached. An output lead 32 provides the other lead of the delay circuit. The condensers C are connected between each coil and the holding bracket 10.

The angle of 55 degrees was selected as the angle between coils because at this angle no mutual flux exists. It may be shown by plotting a field pattern of a thin coil, such as the one shown, that the flux from one coil does not pass to another coil if they are placed parallel along an axis of 55 degrees with their longitudinal axis. The reason for this is that on a 55 degree line the flux from a coil is parallel to the second coil and does not cut any turns. This is shown in Figure 4.

Since there is no mutual flux between adjoining coils, the transfer from coil 26 to 28 by the lead 27 does not introduce a discontinuity into the circuit. If mutual flux did exist between adjoining coils and the transfer between 26 and 28 were made as shown, a discontinuity would exist at the lead 27 in that there would be an abrupt change of impedance.

With the structure shown, an assembly may be made with a predetermined time delay merely by adding sections of coils and capacitance which have known time delays. For example, if each delay section comprising a coil 22 and a capacitor C has a delay of one microsecond, a delay of eight microseconds may be obtained by connecting eight of the sections together. If mutual in-

3

ductance existed, however, this would not be the case, but the resultant delay would be substantially different from the sum of the individual delays. It is not necessary that adjoining rows of delay sections be spaced above each other but they may alternatively be placed side by side, or in any convenient arrangement. The length of the lead 27 may be varied.

It is seen that this invention provides means for assembling a delay line in a fashion such that the total delay may be calculated from the known delay of the individual sections. A first section of the delay assembly may be offset from a second section without inducing any discontinuity in the assembly.

Although this invention has been described with respect to a particular embodiment, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention, as defined by the appended claims.

We claim:

1. An assembled delay line comprising, a holding bracket of a generally H-shape, a plurality of inductance coils mounted in said upper and lower holding portions of said bracket with the axes of said coils forming a 55 degree angle with the longitudinal axis of said bracket, a first input lead connected to one of said coils, the output of said first coil connected to the input of a second coil and each succeeding coil connected to the input of the preceding coil, a condenser connected be-

4

tween the junction of each pair of coils and the holding bracket, a second lead joining the last of the coils in said first holding bracket to the first of said coils in said second holding bracket, and a capacitor connected between said second lead and said bracket.

2. An assembled delay line comprising, a holding bracket formed with a plurality of receiving slots, a plurality of inductance coils mounted in each of said slots with the axis of the coils forming a 55 degree angle with the longitudinal axis of the bracket, capacitive means between each inductance coil and said bracket, a first input lead furnishing an input to one of said coils, a plurality of leads connecting each coil with a succeeding coil, a transmission lead connected between the last coil in each slot and the first coil in a succeeding slot, and an output lead connected to the last of the series connected inductance coils.

NOEL W. HANCOCK.
DAVID O. MCCOY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,577,421	Hazeltine	Mar. 16, 1926
2,390,563	Tawney	Dec. 11, 1945
2,522,731	Wheeler	Sept. 19, 1950