

Oct. 27, 1959

V. J. PORTER

2,910,656

TERMINATIONS FOR ACOUSTIC DELAY LINES

Filed Sept. 28, 1955

FIG. 1.

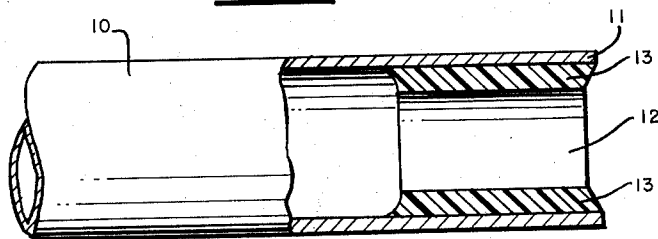
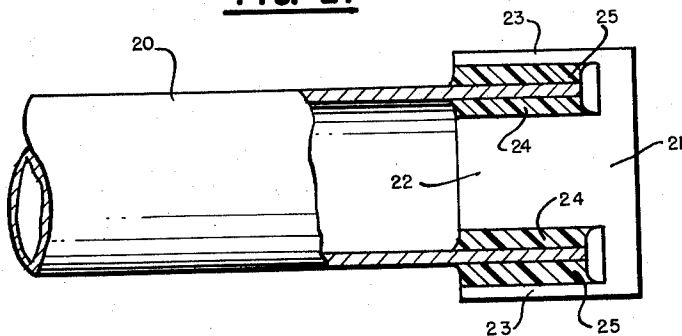


FIG. 2.



INVENTOR.

VINCENT J. PORTER

BY

Charles E. English

AGENT

1

2,910,656

TERMINATIONS FOR ACOUSTIC DELAY LINES

Vincent J. Porter, Huntingdon Valley, Pa., assignor to Sperry Rand Corporation, New York, N.Y., a corporation of Delaware

Application September 28, 1955, Serial No. 537,113

7 Claims. (Cl. 333—30)

The present invention relates to acoustic delay lines and is more particularly concerned with novel structures for non-reflectively terminating such lines more efficiently than has been the case heretofore.

Acoustic delay lines are presently utilized in many electronic applications and may be employed, for instance, in memories for use in computing apparatuses. Reference is made to U.S. Patent No. 2,629,827, of J. P. Eckert, Jr. et al., issued February 24, 1953, for "Memory System," which patent discusses various forms of delay line structures for use in such computer memories. In general, acoustic delay lines of the type contemplated herein are analogous to those taught in the aforementioned Eckert Patent 2,629,827, and comprise an elongated acoustic transmission medium associated with a pair of spaced acoustic transducers.

In practice, information to be delayed or stored is caused to drive one of the said transducers located adjacent the acoustic transmission medium thereby to effect the propagation of an acoustic wave in the said medium. This acoustic wave is subsequently detected by a further acoustic transducer associated with the said transmission medium and spaced from the first mentioned acoustic transducer whereby the information originally impressed upon the first acoustic transducer is delayed by a finite time dependent upon the acoustic delay of the transmission medium employed.

Various forms of acoustic delay lines, operating in the above described manner are known in the art, and certain of these lines are taught in the aforementioned Eckert patent. The acoustic transmission medium may comprise a number of materials; and may, for instance, consist of a magnetostrictive material, in which event the acoustic transducers mentioned may comprise magnetic transducers. The present invention is not to be considered limited by the particular form or material used in the acoustic delay line; and as will be described, finds utility in improving the operating characteristics of acoustic delay lines in general.

It will be appreciated from the operation of acoustic delay lines, as described above, that an acoustic wave propagated in an acoustic transmission medium and detected by an acoustic transducer, must somehow be dissipated subsequent to detection in order to prevent reflections in the line which would give rise to background noise and/or to spurious results. For this reason, therefore, acoustic delay lines must somehow be non-reflectively terminated, and in the case of an elongated transmission medium, such terminations are preferably supplied at each of the opposing ends of the said transmission medium. In the past, acoustic delay line terminations have dissipated energy in propagated waves by a combination of wave scattering and loss of energy at each of a large number of reflections. These known types of terminations have accordingly been subject to the disadvantage that the required terminating structure has been relatively complex in character; and in addition, these known forms of termination have been somewhat less

2

effective than may be desirable in many applications, whereby residual energy from a propagated wave is not completely dispersed and may be reflected and circulated in the acoustic delay line.

The present invention serves to obviate these difficulties and provides a novel and improved form of delay line termination employing a damping material, such as a grease, putty or rubber, whereby the energy of a propagated acoustic wave is more completely and efficiently damped and dissipated, by a structure which is more simple and less costly to provide, than has been the case heretofore.

It is accordingly an object of the present invention to provide an improved acoustic delay line.

A further object of the present invention resides in the provision of novel terminations for acoustic delay lines.

A still further object of the present invention resides in the provision of a terminated acoustic delay line having better operating characteristics than has been the case heretofore.

A further object of the present invention resides in the provision of structure for terminating delay lines whereby acoustic waves propagated in such lines may be more effectively dissipated than has been the case heretofore.

Another object of the present invention resides in the provision of improved terminations for acoustic delay lines which are simpler in structure and less expensive to construct than has been the case in the past.

The foregoing objects, advantages, construction and operation of the present invention will become more readily apparent from the following description and accompanying drawings, in which:

Figure 1 illustrates, in partial section, an acoustic delay line terminated in accordance with one form of the present invention; and

Figure 2 illustrates, in partial section, an acoustic delay line terminated in accordance with a modification of the structure shown in Figure 1.

Referring now to Figure 1, it will be seen that, in accordance with one form of the present invention, an acoustic delay line may comprise an elongated acoustic transmission medium 10 having a tubular configuration. The end 11 of the said transmission medium 10 is meant to be indicative of either elongated end of the said medium 10, and it will be appreciated from the subsequent description that a termination, such as will be described, may in fact be applied to either end or to both ends of the said transmission medium 10.

In accordance with the present invention, the end 11 of transmission medium 10 is terminated by means adapted to absorb the propagated acoustic energy and adapted to prevent reflection of this energy; and these means comprise a solid mass or slug 12 inserted within the tube 10 adjacent an end 11 thereof. The mass or slug 12 may take various cross-sectional configurations, and in a preferred embodiment, the said mass 12 may be cylindrical in configuration. In addition, mass 12 has a somewhat smaller diameter than the internal diameter of the tubular medium 10, whereby mass 12 fits loosely within the end 11 of medium 10, thereby to define an annular damping chamber between the outer periphery of mass 12 and the inner boundary walls of tubular member 10. This annular damping chamber is filled with a viscous damping fluid 13 which may comprise a silicone grease or putty, or other damping materials, and in a preferred embodiment of the present invention, the said damping fluid 13 comprises a body of silicone rubber. By the provision of such a viscous damping fluid 13, and due to its high damping characteristics, longitudinal energy in an acoustic wave propagated in the

3

line 10 toward the end 11 thereof is substantially completely absorbed in the damping material 13. Thus, the extremely simple structure shown in Figure 1, serves to terminate a tubular acoustic transmission medium more efficiently and in a less expensive manner.

To provide even further damping of the longitudinal energy in a propagated acoustic wave, the structure of Figure 1 may be modified in the manner shown in Figure 2 whereby the damping chamber comprises annular spaces adjacent both the inner and outer peripheral walls of the tubular acoustic transmission medium. Thus, referring to Figure 2, it will be seen that an acoustic delay line may once more comprise a tubular member 20 and the ends of the said delay line may be terminated by a structure 21 comprising a loosely fitting inner mass or slug 22 and a cylindrical portion 23 spaced from and closely adjacent to the external peripheral walls of the tube 20. The portions 22 and 23 of termination means 21 may be formed integrally with one another, as shown, or may comprise, in the alternative, separate masses.

In addition, the termination may comprise the cylindrical member 23 alone, spaced adjacent the external peripheral walls of the transmission medium 20 in which case the termination assumes the form of a loosely fitting cup overlapping the end of the acoustic delay line and adapted to receive a viscous damping fluid between the interior surfaces of said cup and the external surfaces of the said delay line. This latter construction finds particular utility when the acoustic transmission medium employed is solid rather than tubular in configuration.

In the particular example illustrated in Figure 2, the viscous damping fluid, which may take one of the forms described in reference to Figure 1, comprises a first body 24 of the said fluid disposed between the central mass or slug 22 and the inner boundary walls of tubular member 20; and a further body 25 of the said damping fluid disposed between the outer peripheral walls of tubular member 20 and the inner boundary surfaces of cylindrical overlapping portions 23. It will be appreciated that when slug 22 is cylindrical in configuration, and when overlapping portions 23 are also cylindrical in configuration, each of the bodies 24 and 25 of viscous damping fluid will fill annular spaces adjacent both the internal and external walls of tubular member 20.

Thus, by employing a terminating element 21 of the type shown in Figure 2, damping fluid may be caused to completely surround an end of the delay line to be terminated, both internally and externally thereof, whereby more efficient damping may be effected by a more simple structure than has been the case in the past. It should further be noted that in each of the examples shown in Figures 1 and 2, the length of the damping chamber, filled with the bodies of damping fluid 13, 24 and 25 respectively, may be adjusted in length when different acoustic transmission medium materials are employed, so as to provide a desired terminating acoustic impedance for the suppression of reflections. This necessary length of damping chamber will vary for different acoustic transmission mediums, and terminating structures such as those shown in Figures 1 and 2 may in fact be adjustable in nature, thereby to permit easy control of the terminating impedance for providing maximum attenuation of an acoustic wave in any given application.

While preferred embodiments of the present invention have been described, many variations thereof will be suggested to those skilled in the art. In particular, the form of delay line may be varied and while a tubular delay line has been illustrated, it will be appreciated that the use of a viscous damping fluid in accordance with the present invention may be applied to other configurations of delay line, including solid delay lines. In addition, the particular damping fluids described, although representing preferred embodiments of the present invention, may be replaced by other viscous fluids exhibiting the desired damping characteristics. Further, while the dis-

4

position and configuration of the terminating structure, as described, provides one or more annular damping chambers, it will be appreciated that by suitable changes in this disposition and configuration of terminating structure, other shapes of damping chamber may be provided.

Still further modifications will be suggested to those skilled in the art, and it must, therefore, be stressed that the foregoing description is meant to be illustrative only and should not be considered limitative of my invention. All such modifications as are in accord with the principles described are meant to fall within the scope of the appended claims.

Having thus described my invention, I claim:

1. In combination, an elongated acoustic delay line of substantially tubular configuration having an open substantially annular end, means for terminating said open end of said delay line comprising a massive cap structure fitting over said end, said cap structure including a massive slug inserted into said open end and loosely fitting therein whereby the outer walls of said slug are spaced from the inner tubular walls of said delay line adjacent said open end, said cap structure further including a substantially cylindrical end structure loosely fitting over the outer tubular walls of said delay line adjacent said open end whereby the inner walls of said substantially cylindrical end structure are spaced from the outer walls of said substantially tubular delay line adjacent said open end, said cylindrical end structure being closed at one end thereof by an end wall extending in spaced relation to said open end of said delay line in a direction transverse to the direction of elongation of said delay line, one end of said massive slug being attached to said end wall of said cylindrical end structure whereby said cap structure comprises a unitary structural body having portions disposed in spaced relation to both the inner and outer tubular walls of said delay line adjacent said open end, and a resilient damping material disposed between the outer walls of said slug and the inner walls of said delay line adjacent said open end, said resilient damping material also being disposed between the outer walls of said delay line and the inner walls of said cylindrical end structure adjacent said open end, the unitary structural body comprising said cap structure being directly supported, both internally and externally of said delay line, adjacent said open end of said delay line by said damping material whereby said damping material maintains said unitary cap structure in substantially concentric relation to said delay line adjacent said open end.

2. The combination of claim 1 wherein said slug, end wall, and cylindrical end structure are integral with one another.

3. In combination, an elongated acoustic delay line of substantially tubular configuration having an open end comprising a unitary portion thereof, and means for terminating said open end, said terminating means comprising a massive substantially cylindrical slug inserted into and loosely fitting within said tubular delay line adjacent said unitary open end, the length of said slug being short in comparison to the length of said delay line whereby said slug defines a first end closely adjacent to the open end of said delay line and said slug also defines a second free end spaced from said open end at a position internal of said delay line, and a body of resilient damping material disposed in the annular space between the outer walls of said loosely fitting cylindrical slug and the inner walls of said tubular delay line, said slug being directly supported and positionally maintained in substantially concentric relation to said delay line by said damping material alone, said terminating means further including a cylindrical cap structure having portions overlying and spaced from the outer walls of said tubular delay line adjacent said open end, and a further body of resilient damping material disposed in the space between the outer walls of said tubular delay line and said overlying portions

5

of said cylindrical cap structure for directly supporting and positionally maintaining said cap structure in substantially concentric relation to said delay line adjacent said open end.

4. In combination, an elongated acoustic delay line of substantially tubular configuration having an open end, and means for terminating said open end comprising a massive substantially cylindrical slug inserted into and loosely fitting within said tubular delay line adjacent said open end, the length of said slug being short in comparison to the length of said delay line whereby said slug defines a first end closely adjacent to the open end of said delay line and said slug also defines a second free end spaced from said open end at a position internal of said delay line, a cylindrical cap structure attached to said first end of said slug adjacent said open end of said delay line, said cap structure having portions overlying and spaced from the outer walls of said tubular delay line adjacent said open end, a body of resilient damping material disposed in the annular space between the outer walls of said loosely fitting cylindrical slug and the inner walls of said tubular delay line, said slug being directly supported and positionally maintained in substantially concentric relation to said delay line by said damping material alone, and a further body of resilient damping material disposed in the space between the outer walls of said tubular delay line and the said overlying portions of said cylindrical cap structure for directly supporting and positionally maintaining said cap structure in substantially concentric relation to said delay line adjacent said open end.

5. In combination, an acoustic delay line having a substantially tubular open end comprising an integral portion of said delay line, and means for terminating said delay line comprising a massive slug inserted into and loosely fitting within said tubular open end such that said slug is spaced from the internal walls of said tubular open end, a first body of resilient damping material disposed in the space between the outer walls of said loosely fitting slug and the inner walls of said tubular delay line end, said slug being directly supported within and positionally maintained in substantially concentric relation to said tubular delay line end by said first body of damping material alone, a second body of resilient damping material separate and distinct from said first body, said second body of damping material being

6

disposed in surrounding relation to said hollow tubular end at a position adjacent the exterior walls of said delay line, and means extending from said massive slug over the end of said delay line into contiguity with said second body of resilient damping material for retaining said second body in place adjacent the exterior walls of said delay line.

6. In combination, an acoustic delay line having a open end, and unitary means for terminating said open end, said unitary means comprising a first massive portion inserted into and loosely fitting within said open end in spaced relation to the interior walls of said delay line, said unitary means comprising a second massive portion extending over the outer walls of said delay line in spaced relation to said outer walls adjacent said open end, and resilient damping material disposed in the space between the outer surfaces of said first portion and the inner walls of said delay line as well as between the inner surfaces of said second portion and the outer walls of said delay line, said unitary means being directly supported and positionally maintained adjacent the open end of said delay line by said damping material alone.

7. In combination, an acoustic delay line of substantially tubular configuration having an open end, means for terminating said open end comprising a unitary massive cap structure loosely fitting over said end to cover the external walls of said delay line adjacent said open end in spaced relation to said external walls, massive means attached to and projecting from said cap structure, said massive projecting means extending into said open end of said delay line in spaced relation to the internal walls of said tubular delay line, and resilient damping means disposed between the walls of said delay line and adjacent portions of said massive cap structure, whereby said damping means resiliently supports said unitary loosely fitting cap structure in place adjacent both the internal and external walls of said delay line.

References Cited in the file of this patent

UNITED STATES PATENTS

2,559,905	Turner	July 10, 1951
2,736,823	Sheppard et al.	Feb. 28, 1956

FOREIGN PATENTS

714,627	Great Britain	Sept. 1, 1954
---------	---------------	---------------