

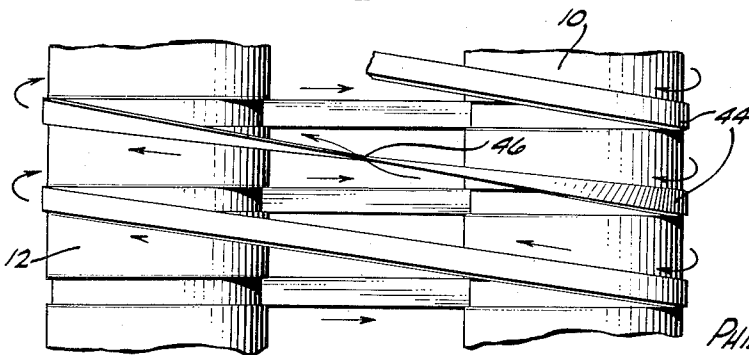
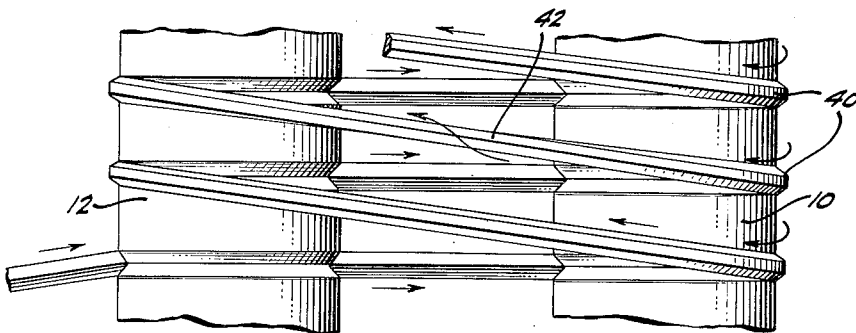
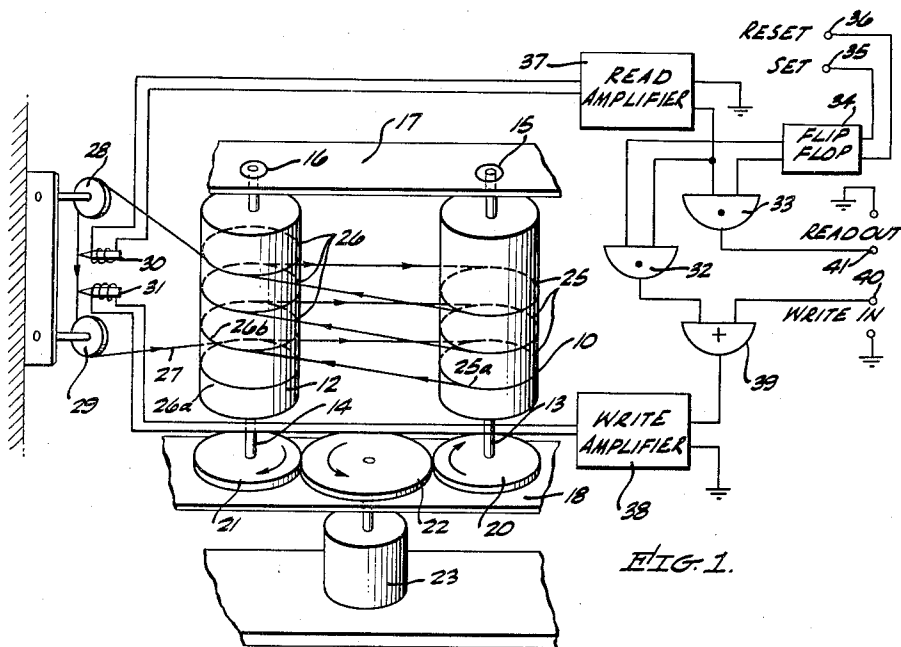
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LARGE CAPACITY CLOSED-LOOP DELAY APPARATUS

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1

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LARGE CAPACITY CLOSED-LOOP
DELAY APPARATUS

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4 Claims. (Cl. 340-174.1)

This invention relates to digital computer apparatus and more particularly to a large capacity closed-loop delay and storage apparatus requiring only one write-head and only one read-head.

At the present time when faced with the problem of delaying and storing several hundred thousand bits of information, it is the practice to combine a number of circumferential paths of a magnetic storage drum by appropriately connecting a read- and a write-head for each such path about the drum. Each read-head and write-head thus employed, however, requires its associated amplifier and introduces some deterioration of the information delayed and stored.

In accordance with the present invention, first and second cylinders are designed so as to be capable of rotation about parallel axes. These cylinders have corresponding pluralities of circular grooves which are respectively centered in planes which are all normal to the axis of rotation. An endless loop of magnetic wire is then wound about the cylinders so as to extend from each groove of the first cylinder to a groove substantially opposite therefrom on the second cylinder and then return to a groove immediately adjacent the groove on the first cylinder. The magnetic wire is returned from one extremity of the cylinder to the other by means of appropriate pulleys thereby to allow the cylinders to be rotated. A write-head is disposed along the magnetic wire for the purpose of writing information on the wire and a read-head for reading and erasing the information is spaced along the wire by a distance adapted to introduce the desired delay and storage interval.

In the above case, maximum delay for a given wire velocity is achieved by placing the read-head immediately adjacent the write-head with the wire traveling from the read-head to write-head in the short distance therebetween. For the same velocity this delay may be doubled by employing a tape and turning it over or twisting it once in placing it about the cylinders or between the pulleys. More generally, a polygon-sided wire may be employed and the delay increased by the number of sides, n , of the polygon by twisting the wire through an angle equal to $360^\circ/n$ in going around the cylinders. Alternatively, a wire having a square cross-section may be employed and two delay lines each having a delay equal to twice that afforded by a single length of the wire provided by twisting the wire through 180° in going about the cylinders.

It is therefore an object of the present invention to provide an improved large-capacity delay and storage apparatus.

Another object of the invention is to provide a large capacity closed-loop storage device including a magnetic multisided wire or tape which is twisted in a manner to make the entire surface area thereof available for information storage purposes.

Still another object of the present invention is to provide a large capacity closed-loop delay line and storage system which necessitates the utilization of only one write-head and one read-head per loop.

The above-mentioned and other features and objects of this invention and the manner of obtaining them will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, wherein:

2

FIG. 1 illustrates a perspective view of the device of the present invention;

FIG. 2 shows a partial view of the device of FIG. 1 adapted to utilize five-sided magnetic wire with a 72° twist; and

FIG. 3 shows a partial view of the device of FIG. 1 adapted to utilize magnetic wire tape having a 180° twist.

Referring now to the drawing, FIG. 1 illustrates a preferred embodiment of the device of the present invention wherein cylinders 10, 12 are mounted coextensively along parallel axes on rods 13, 14, respectively, which are also parallel. The top of the rods 13, 14, as viewed in the drawing, are mounted in bearings 15, 16, respectively, which are attached to a support member 17. The rods 13, 14 are separated by a distance determined, in part, by the length of delay line desired. The bottom end of rods 13, 14, as viewed in the drawing, are rotatably mounted in a support member 18 with the rods separated by the same distance as in the member 17. Also attached to the rods 13, 14 adjacent the member 18 are gear wheels 20, 21, respectively. The gear wheels 20, 21 are engaged to a common drive gear 22 which is, in turn, rotated by a motor 23 which may be of the synchronous type, if desired. The relative diameters of the gear wheels 20, 21, 22 are determined by the diameters of the cylinders 10, 12, which diameters obviously need not be the same. The only restriction is that the peripheral velocity of each cylinder 10, 12 be the same. Thus, for example, if the diameter of cylinder 12 were substantially larger than the diameter of cylinder 10, the diameters of the gears 20, 21, 22 would be chosen so that the cylinder 10 would rotate at a correspondingly faster angular velocity than the angular velocity of cylinder 12.

In accordance with the present invention, cylinder 10 has a plurality of circular grooves 25, and cylinder 12 has a corresponding plurality of circular grooves 26. Each of the grooves 25, 26 lies in planes that are normal to the axis of rotation of the respective cylinders 10, 12. A magnetic wire 27 is then wrapped partially about a circular groove 26a nearest the lower extremity of cylinder 12, as viewed in the drawing, and wrapped about a circular groove 25a nearest the lower extremity of cylinder 10 and then returned to a circular groove 26b of cylinder 12 which is immediately adjacent the groove 26a. In general, the magnetic wire 27 is wrapped about a groove 26 on cylinder 12 and then wrapped one-half turn about the nearest opposite groove 25 in cylinder 10 and then returned to a groove 26 on cylinder 12 that is immediately adjacent the groove 26a. This procedure is followed until the desired length of magnetic wire 27 is maintained taut about the cylinders 10 and 12. The magnetic wire 27 is then returned from the top to the bottom of cylinder 12, as viewed in the drawing, by means of pulleys 28, 29, which pulleys are mounted so as to rotate in a plane which intersects the axis of rotation of the cylinder 12. It is considered that the use of additional cylinders similar to cylinders 10 and 12 which rotate on an axis or axes that are parallel to the ones of cylinder 10, 12 and the use of a single large diameter pulley is in lieu of pulleys 28, 29 within the scope of the teachings of the instant specification.

In operation, the motor 23 rotates the cylinders 10, 12 so that the magnetic wire 27 travels thereabout at a uniform velocity and proceeds from the pulley 28 to the pulley 29 in a downward direction, as viewed in the drawing. A read-head 30 and a write-head 31 are arbitrarily mounted along the portion of the magnetic wire 27 which lies between the pulleys 28, 29, such that the magnetic wire 27 leaving the cylinders 10, 12 first passes under the read-head 30 and then under the write-head 31 prior to returning to the cylinders 10, 12. The read-head 30 is coupled to a read-amplifier 37 which, in

turn, provides an output that is connected to inputs of both "and" gates 32 and 33. The complementary and principal outputs of a flip-flop 34 are also connected, respectively, to the "and" gates 32, 33, whereby only one of the "and" gates 32, 33 can produce the read amplifier 37 output signal at its respective output at any one time. The state of the flip-flop 34 is controlled by a set input 35 and a reset input 36. The output of "and" gate 32 is connected through an "or" gate 39 to the input of a write amplifier 38 which drives the write-head 31. The "or" gate 39 also has an additional input from write-in terminals 40. "And" gate 33, on the other hand, has an output connected to read-out terminals 41. Thus, if it is desired to recirculate the information stored by the magnetic wire 27, the flip-flop 34 is set so that an information level signal appears at the complementary output thereof so that information applied to the "and" gate 32 from the read amplifier 37 is allowed to go through and return to the write amplifier 38. On the other hand, if it is only desired to store and delay the information originally written on the magnetic wire 27, the flip-flop 34 is set so that an information level signal appears at the principal output thereof, which output is applied to the "and" gate 33. Thus, information written on magnetic wire 27 is delayed for an interval determined by the length and velocity of magnetic wire from the write-head 31 around the cylinders 10, 12, back to the read-head 30. Alternatively, an information level signal applied to the "and" gate 33 by the flip-flop 34 will connect the read amplifier 37 to the read-out terminals 41.

Referring now to FIGS. 2 and 3 of the drawing, there are shown embodiments that are adapted to the use of a plurality of read-heads and write-heads and which also extend the usable length of the magnetic wire by making available the entire surface area of the wire for storing information. Referring now to FIG. 2, there is shown a partial perspective view of the device of FIG. 1 wherein a wire 40 having a pentagon-shaped cross-section with five equal-width sides is employed in lieu of the magnetic wire 27. The use of the wire 40 with a pentagon-shaped cross-section is adaptable but not restricted to making the grooves 25, 26 in the cylinders 10, 12 triangular shaped. Thus, when the wire 40 is in the grooves 25, 26, the exterior portion forms an annular surface that is parallel to the surface of the respective cylinder. An advantage of this particular configuration is that a read-head or a write-head may be used at any point along the cylinder and may be oriented so as to be perpendicular to the surface of the cylinder and to its axis of rotation. In addition to the foregoing, a single twist 42 of 72° may be introduced in the wire 40 preferably in passing directly from cylinders 10 or 12 to cylinders 12 or 10, respectively. The twist 42 will have the effect of rotating the wire 40 through 72° for each complete revolution about the cylinders 10, 12. Thus, information stored or recorded on the magnetic wire 40 by the write-head 31 will make five complete cycles before coming under the read-head 30. In general, this phenomenon may be stated generally by choosing a wire having " n " sides and introducing a single twist of $360^\circ/n$ wherein n is a positive integer that is equal to two or more. This twist may be concentrated in one place so long as it does not come between the write-head 31 and the read-head 30 when proceeding in the direction the wire is moving.

Referring to FIG. 3, there is shown a partial perspective view of the device of FIG. 1 wherein a flat tape 44 with a single twist 46 is employed. In this instance there are two sides to the tape 44; hence, $n=2$. The twist 46 introduced in this instance then is $360^\circ/2=180^\circ$. This particular configuration will effectively double the length of the tape 44 and, hence, correspondingly increase the available delay. In mechanizing the disclosed embodiments, the magnetic wires 27, 40, or tape 44 may be made from any material having suitable tensile strength

and magnetic properties. For example, stainless steel or other material of high permeability with a coating of nickel cobalt alloy may be used.

What is claimed is:

1. A long-line delay device comprising a first cylinder having a predetermined axis of rotation and a plurality of grooves disposed about the periphery thereof in respective planes that are normal to said axis of rotation; a second cylinder spaced from and co-extensive with at least a portion of said first cylinder and having an axis of rotation that is parallel to said predetermined axis of rotation, said second cylinder having a corresponding plurality of grooves disposed about the periphery thereof in respective planes that are normal to said axes of rotation; a continuous longitudinal magnetic member disposed about and from each groove of said first cylinder to and about each corresponding groove of said second cylinder; means for returning said continuous longitudinal magnetic member from the outermost groove at one extremity of one of said first and second cylinders to the outermost groove at the opposite extremity of one of said first and second cylinders; means coupled to at least one of said first and second cylinders for rotating said cylinders; means disposed adjacent a first elemental portion of said longitudinal magnetic member for affecting the magnetic configurations thereof in accordance with an intelligence signal; and means disposed along a second elemental portion of said longitudinal magnetic member spaced from said first portion in the direction of travel for converting said magnetic configurations into a delayed intelligence signal.

2. A long-line delay device comprising a first cylinder having a predetermined axis of rotation and a plurality of grooves disposed about the periphery thereof in respective planes that are normal to said axis of rotation; a second cylinder spaced from and co-extensive with at least a portion of said first cylinder and having an axis of rotation that is parallel to said predetermined axis of rotation, said second cylinder having a corresponding plurality of grooves disposed about the periphery thereof in respective planes that are normal to said axes of rotation; a continuous longitudinal magnetic member having a uniform cross-section of n equal-width wherein n is an integer no less than two, said member being disposed about and from each groove of said first cylinder to and about each corresponding groove of said second cylinder; means for returning said continuous longitudinal magnetic member from the outermost groove at one extremity of one of said first and second cylinders to the outermost groove at the opposite extremity of one of said first and second cylinders; means coupled to at least one of said first and second cylinders for rotating said cylinders at corresponding angular velocities to produce substantially equal tangential velocities at the base of the respective grooves thereof; first means disposed adjacent a first elemental portion of said longitudinal magnetic member for affecting the magnetic configurations thereof in accordance with an intelligence signal; second means disposed along a second elemental portion of said longitudinal magnetic member spaced from said first elemental portion in the direction of travel of said magnetic member for converting said magnetic configurations into a delayed intelligence signal; and means for introducing a twist of $360^\circ/n$ in said longitudinal magnetic member between said first and second means to increase said delay.

3. The long-line device as defined in claim 2 wherein said grooves about the respective peripheries of said first and second cylinders have a triangular shaped cross-sectional configuration and wherein $n=5$, whereby the outermost side of said continuous longitudinal magnetic member constitutes an annular surface that is parallel to the respective surface of said first and second cylinders.

4. A long-line delay device comprising a first cylinder having a predetermined axis of rotation and a plurality of grooves disposed about the periphery thereof in respec-

5

tive planes that are normal to said axis of rotation; a second cylinder spaced from and co-extensive with at least a portion of said first cylinder and having an axis of rotation that is parallel to said predetermined axis of rotation, said second cylinder having a corresponding plurality of grooves disposed about the periphery thereof in respective planes that are normal to said axes of rotation; a longitudinal magnetic tape disposed about and from each groove of said first cylinder to and about each corresponding groove of said second cylinder; means for returning said continuous longitudinal magnetic tape from the outermost groove at one extremity of one of said first and second cylinders to the outermost groove at the opposite extremity of one of said first and second cylinders; first means disposed adjacent a first elemental por-

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tion of said longitudinal magnetic tape for affecting the magnetic configurations thereof in accordance with an intelligence signal; second means disposed along a second elemental portion of said longitudinal magnetic tape spaced from said first elemental portion in the direction of travel of said magnetic tape for converting said magnetic configurations into a delayed intelligence signal; and means for introducing a resultant twist of 180° in the portion of said longitudinal magnetic tape from said first means along the direction of travel to said second means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,047,844

July 31, 1962

Philip N. Armstrong

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 43, after "equal-width" insert -- sides --.

Signed and sealed this 1st day of January 1963.

SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents