The invention relates to a circuit arrangement for reversing a magnetic field comprising a capacitor and a first coil, which form a resonant circuit.

Such circuit arrangements are used, for example, in magneto-optical recording and reproduction devices in order to reverse the direction of magnetization in the magnetic layer of a magneto-optical recording medium.

A known magneto-optical recording medium is the magneto-optical disk in which a magneto-optical layer is disposed behind a transparent layer, and data can be recorded and said data can be read from said magneto-optical layer. It is first explained how the data are written on to a magneto-optical disk.

The magneto-optical layer is heated up to a temperature near to the Curie temperature by means of a laser beam focused onto the disk. In most cases, however, it is sufficient to warm up the magneto-optical layer only to about the compensation temperature, which lies below the Curie point. An electromagnet is disposed behind the focal point on the disk, and said electromagnet magnetizes the region heated up by the laser beam in one or the other direction of magnetization. The direction of magnetization determined by the electromagnet remains stable because, after the laser beam is switched off, the heated area cools down again to a temperature below the compensation temperature. The direction of magnetization freezes, so to speak. In this way, the individual bits are stored in domains of different directions of magnetization. For example, one direction of

magnetization of a domain corresponds to a logical One while the opposite direction of magnetization represents a logical Zero.

For reading the data the Kerr effect is utilised. The plane of polarisation of a linearly polarized light beam is rotated upon reflection at a magnetized mirror by a measurable angle. Depending upon the direction in which the mirror is magnetized, the plane of polarization of the reflected light beam is rotated towards the right or the left. However, because the individual domains on the disk act as magnetized mirrors, the plane of polarization of a scanning light beam is rotated towards the right or towards the left by a measurable angle depending on the direction of magnetization of the domain currently scanned.

The optical scanning device detects, by means of the rotation of the plane of polarization of the light beam reflected from the disk, which bit is present, a logical One or a logical Zero.

A known solution for magnetizing the magneto-optical layer in the one or the other direction provides a circuit arrangement acting as an electromagnet comprising a coil behind the magneto-optical disk. The coil must be dimensioned in such a way that it is capable of reversing the magnetization of the entire area covered by the optical scanning device. Depending on the type of recording and reproduction apparatus this area is, for example, a radial or arcuate strip running from the edge of the disk to the centre of the disk. As the field

intensity must attain a minimum value over the entire strip in order to be able to reverse the magnetization of the strip, the cross section and hence the inductivity of the coil are dimensioned rather large.

In a further known solution the coil is attached to the optical scanning device. The coil can be, for example, wound around the objective lens of the optical scanning device. As in this solution the coil is guided, by means of a tracking control circuit, together with the optical scanning device, along the data tracks on the magneto-optical disk, a small cross section and thus a small inductivity is sufficient for generating the same minimum field strength, because what is reverse magnetized is not a radial or arcuate strip but, rather, only a small, for example, circular area with the nearly dot shaped laser spot as the centre point in the magneto-optical layer.

From US-A 3 337 748 there is known a circuit arrangement for triggering a coil, in which a charging capacitor is connected in parallel to the coil to form a resonant circuit. The charging capacitor is charged by the coil current still flowing upon switching off or switching over. In resonance operation there is thus generated a pulse with a pulse length corresponding to the resonance frequency.

It is, therefore, the object of the invention to provide a circuit arrangement with a coil in such a manner that a secure and fast reversal of the magnetic field is attained.

The invention achieves this object in that the capacitor, a first controllable switch as well as a series connection of the first coil and a second controllable switch are connected in parallel, that a current source is connected to the two terminals of the second controllable switch, that the first and second controllable switches are controlled by a control circuit, that in the basic state, the first controllable switch is closed, while the second controllable switch is open, that for reversing the magnetic field of the first coil the control circuit, in a first switching step, opens the first controllable switch and simultaneously closes the second controllable switch, that, in a second switching step, the control circuit closes again the first controllable switch and opens again the second controllable switch when the coil current has risen again to the absolute maximum following a reverse charging cycle of the capacitor.

Figure 1 shows a first embodiment of the invention

Figures 2 to 7 show the first embodiment with different switch positions for explaining its functioning

Figure 8 shows the current I through the coil

Figure 9 shows the voltage U at the capacitor

Figure 10 shows a second embodiment of the invention.

A first embodiment of the invention is first described with reference to Figure 1 and subsequently explained with reference to Figures 1 to 9.

In Figure 1 there are provided a parallel connection of a capacitor C, a series connection of a diode D and a controllable switch S1 as well as a series connection of a coil SP1 and a controllable switch S2, the two terminals of which are connected to the poles of a current source Q. Diode D is biased in conducting direction for the current source Q. The control inputs of the two controllable switches S1 and S2 are connected to a controller device G.

The first embodiment is now explained with reference to Figures 1 to 9.

In Figure 1 the controllable switch S1 is closed while the controllable switch S2 is open. Therefore, a constant current I, supplied by the current source Q, flows through the coil SP. The voltage U at the capacitor C is therefore zero.

At time t1 the control circuit G causes controllable switch S1 to open and controllable switch S2 to close in order to short-circuit current source Q. The coil current I now slowly decreases while simultaneously the voltage U at the capacitor C climbs to an absolute maximum Umax. This state is shown in Figure 2.

At time t2 the voltage Umax at the capacitor C is at maximum, while simultaneously the coil current I becomes zero as indicated in Figure 3. As capacitor C now discharges, the voltage U decreases while simultaneously the coil current I, flowing in the other direction, increases. This state is shown in Figure 4.

At time t3 the capacitor C is completely discharged - consequently, the voltage U is zero - while the coil current I reaches the absolute minimum Imin. at time t3. The capacitor C is now reverse charged, as can be seen from Figure 5.

During the reverse charging process, shown in Figure 6, the coil current I rises from the absolute minimum Imin to the value zero; at the same time the voltage U at the capacitor C drops from the value zero to the absolute minimum Umin at time t4. As the capacitor C is now reverse charged, the voltage U increases from the absolute minimum Umin to the value zero while simultaneously the coil current I rises from the value zero to the absolute maximum Imax. This reverse charging process is illustrated in Figure 7.

At time t5 the control circuit G closes controllable switch S1 and opens controllable switch S2 so that current source Q may again supply a current which flows from one pole of the current source Q via the coil SP, the diode D and the controllable switch S1 back to the other pole of the current source Q. The original state depicted in Figure 1 has now again been reached. A new cycle of current reversal and, therewith, the reversal of the magnetic field generated by the coil SP can now begin.

The diode D is not required for the functioning of the invention. However, it has the advantage that the controllable switch S1 can be closed even from time t3 because it prevents the energy stored in the capacitor

and in the coil SP from being short-circuited by the controllable switch S1. Without the diode D the controllable switch S1 has to be closed exactly at time t5. With the diode D the closing of controllable switch can thus occur between times t3 and t5. From time t5 on, the controllable switch S2 can be opened.

In Figure 10 a second embodiment is depicted which shows the construction of the current source Q.

A series connection of a coil SP2 and a freewheeling diode FD is arranged in parallel to the controllable switch S2. The connection point of the coil SP2 and the freewheeling diode D is clamped, by means of a controllable switch S3, to one pole of a supply voltage source VS, the other pole of which is connected to the common connection point of the freewheeling diode FD and the controllable switch S2. A Hall sensor HS measuring the current through coil SP2 is connected to the input of a two-step controller RG, the output of which is connected to the control input of the controllable switch S3. The two-step controller RG regulates, by means of opening and closing controllable switch S3, the current through the coil SP2 to a constant value.

An essential advantage of the invention lies in the fact that it meets the two usually conflicting demands of low energy consumption and, at the same time, simple design.

With magneto-optical recording and reproduction apparatus the invention offers the advantage that data already recorded on the magneto-optical disk can be directly

overwritten. With known magneto-optical recording and reproduction apparatus, in contrast, the old data are first erased before new data are recorded.

For this purpose the magneto-optical layer, at the locations where the new data are to be stored, is heated by the laser to the compensation temperature. These locations are thus magnetized in the one direction. The disk is initialized, which is the technical term for this process. Subsequently, the direction of the magnetic field generated in the coil is again reversed.

For recording of the new data the laser output is switched between a low and a high value depending on the bit to be stored. If, for example, a logical Zero is stored at the prior erased location then the laser operates at low output so that the compensation temperature is not reached. For recording a logical One, however, the laser heats up the location to be newly written to the compensation temperature so that this location can be reverse magnetized by the coil. In this complicated manner, data on the magneto-optical disk are first erased before, subsequently, the new data are recorded.

The invention is suitable not only for magneto-optical apparatus but also for other magnetic recording apparatus.

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## Claims

1. A circuit arrangement for the reversal of a magnetic field, with a capacitor (C) and a first coil (SP1) which form a resonant circuit, characterised in that the capacitor (C), a first controllable switch (S1) as well as a series connection of the first coil (SP1) and a second controllable switch (S2) are connected in parallel, that a current source (Q) is connected to the two terminals of the second controllable switch (S2), that the first and the second controllable switches (S1, S2) are controlled by a control circuit (G), that in the basic state, the first controllable switch (S1) is closed, while the second controllable switch (S2) is open, that for reversing the magnetic field of the first coil (SP1) the control circuit (G), in a first switching step, opens the first controllable switch (S1) and simultaneously closes the second controllable switch (S2), that, in a second switching step, the control circuit (G) closes the first controllable switch (S1) and opens again the second controllable switch (S2) when the coil current (I) has risen again to the absolute maximum (Imax) following a reverse charging cycle of the capacitor (C).

2. A circuit arrangement according to claim 1, characterised in that a diode (D) is connected in series with the first controllable switch (S1) in order to block the current path through the first controllable switch (S1).

* C L M S *

3. A circuit arrangement according to claim 2, characterised in that in the second switching step, the control circuit (G) closes again the first controllable switch (S1) in the time interval (t3, t5) during which the coil current (I) climbs from the absolute minimum (Imin) to the absolute maximum (Imax).

4. A circuit arrangement according to claim 1,2 or 3, characterised in that a series connection of a second coil (SP2) and a freewheeling diode (FD) is arranged in parallel with the two terminals of the second controllable switch (S2), that the common connection point of the second coil (SP2) and the freewheeling diode (FD) is connected, via a third controllable switch (S3), to the one pole of a supply voltage source (VS), the other pole of which is connected to the common connection point of the second controllable switch (S2) and the freewheeling diode (FD), that there is arranged at the second coil (SP2) a current sensor element (HS) which is connected to the input of a controller (RG), which controls the current through the second coil (SP2), and that the output of the controller (RG) is connected to the control input of the third controllable switch (S3).

5. A circuit arrangement according to claim 4, characterised in that a Hall probe is provided as the current sensor element (HS).