

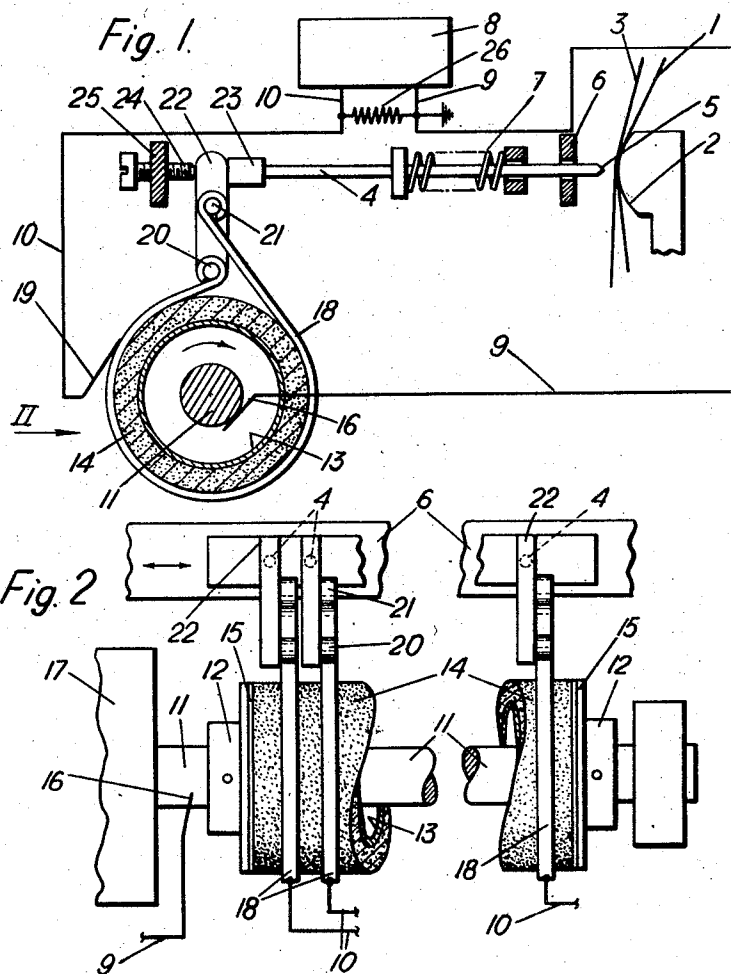
Sept. 9, 1958

A. FOSTER
MOTION TRANSMITTERS

2,850,907

Filed June 11, 1957

2 Sheets-Sheet 1



Inventor
ALAN FOSTER
By
Wm. H. Shirley
Attorney

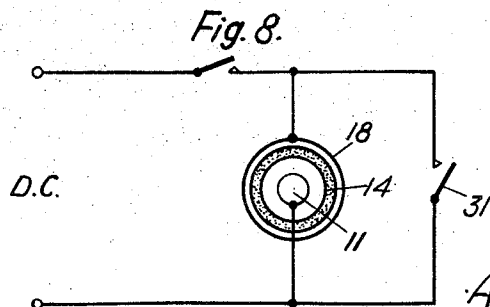
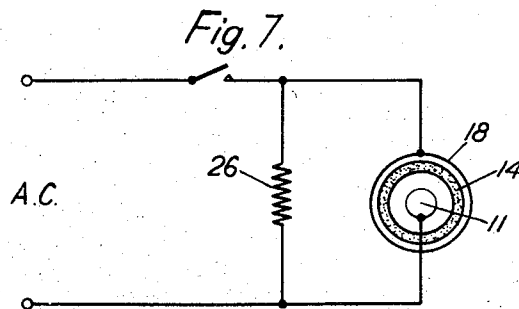
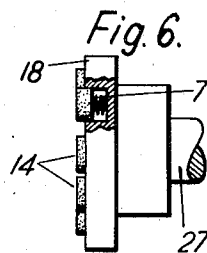
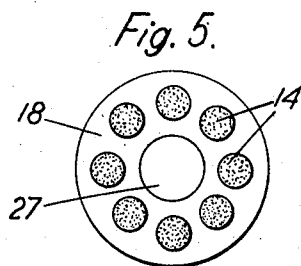
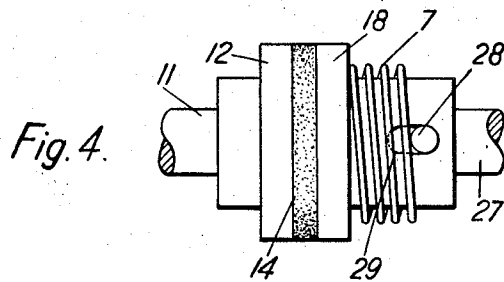
Sept. 9, 1958

A. FOSTER
MOTION TRANSMITTERS

2,850,907

Filed June 11, 1957

2 Sheets-Sheet 2



Inventor
ALAN FOSTER
By
Miner and Seiler

1

2,850,907

MOTION TRANSMITTERS

Alan Foster, Croydon, England, assignor to Powers-Samas Accounting Machines Limited, Holborn Bars, London, England, a British company

Application June 11, 1957, Serial No. 664,930

Claims priority, application Great Britain August 3, 1956

12 Claims. (Cl. 74—25)

This invention relates to motion transmitters and in particular to a new form of transmitter which is adapted to transmit either reciprocatory, oscillatory, or rotary motion from a continuously operable driving member.

It is well known that the force of attraction between mutually charged surfaces is proportional to the square of the electric stress between the surfaces for any given dielectric. The electric stress being defined as the potential between the surfaces divided by the distance between them.

It has been proposed in French Patent No. 533,368, Erich F. Huth to make use of this principle by the use of a dielectric disposed between two electrically conductive surfaces connected in an electric circuit and so arranged as at all times to be movable relatively one to the other so that voltage variations in the circuit cause differences in the frictional contact between the surfaces and so permit, as a function of the voltage variations, the transmission of movements of varying magnitude.

It is a main object of the present invention so to make use of the said known principle as to provide devices capable of transmitting reciprocatory or oscillatory movements solely as the result of movement of a driving member, or of transmitting rotation to a driven member solely as the result of the angular movement of a rotatable driving member.

According to the present invention there is provided a motion transmitter comprising a continuously operable driving member and a driven member supported for relative movement along the line of movement of the driving member and each having an electrically conductive face connected in an electric circuit and arranged respectively to engage the opposite sides of an intermediate material extending therebetween and movable with one of said members, wherein the intermediate material has a dielectric constant and thickness such that on energization of the circuit by current having a constant peak value voltage electric stress causes attraction to effect locking of the driven member to the driving member thereby to cause cessation of relative movement between the members, and the driven member is released from the driving member on de-energization of the circuit by shunt means connected across said conductive faces.

In order that the invention may be clearly understood some embodiments thereof will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Fig. 1 is an end elevation, partly in section, of a motion transmitter according to the invention for transmitting reciprocatory movement,

Fig. 2 is a broken elevation looking in the direction of arrow II, Fig. 1,

Fig. 3 is a pulse waveform diagram,

Fig. 4 is a diagrammatic side view of a motion transmitter, in the form of a clutch,

Fig. 5 illustrates one part of a modified form of the clutch shown in Fig. 4,

Fig. 6 is an end view of Fig. 5,

2

Fig. 7 is an A. C. circuit diagram for operating a transmitter according to the invention, and

Fig. 8 is a D. C. circuit diagram for operating a transmitter according to the invention.

Like reference numerals indicate like or similar parts throughout the figures of drawing.

Referring to Figs. 1 to 3 of the drawings, the definition of characters on impression-receiving material 1 is effected by dots formed by styluses during lateral reciprocation and lengthwise movement thereof as described in British patent specification No. 707,736. During an imprinting operation the impression-receiving material 1, Fig. 1, is located between a platen 2 and a carbon ribbon or other similar transfer media 3.

Imprinting is effected by a plurality of styluses 4, each stylus being arranged to effect the definition of a character independently of the others. The styluses 4 consist of wire-like elements arranged in side-by-side relation and the marking ends 5 thereof, Fig. 1, are engaged by a bar 6 which is arranged to reciprocate the marking ends 5 of the styluses in a straight-line path at right angles to the direction of movement of the impression-receiving material 1 over the platen. Reciprocation of the bar 6 is effected in any suitable manner, not shown, and the amplitude of reciprocation determines one maximum dimension of the characters to be formed. The other maximum dimension of the characters to be formed is determined by the rate of movement of the impression-receiving material 1 during character definition. The styluses 4 are urged to the inactive positions thereof by springs 7, one for each stylus, and imprinting is effected, in the known manner, by axial or lengthwise movements of the styluses 4 against the action of their springs 7.

The axial movements of the styluses 4 are controlled by electrical pulses transmitted from an electrical pulse generator 8 which may be of any suitable form adapted to produce electrical pulses according to the characters to be defined and the outputs from the generator are controlled by a decoding device, not shown, connected with a record sensing or analysing device and an accumulator also not shown.

The generator 8 is connected by lines 9, 10 with an electrically conductive driving member and an electrically conductive driven member arranged to be movable relative one to the other along the line of movement of the driving member. The driving member comprises an electrically conductive shaft 11, and an electrically conductive flanged boss 12 secured to the shaft and making electrical contact with an electrically conductive liner 13 which, by a suitable adhesive, is adhered to the interior of a hollow cylinder 14 so as to provide an electrically conductive face which engages one side of the cylinder and is adapted for connection to line 9. The liner 13 may be made of silver and, to ensure good electrical connection between the boss 12 and liner 13 the end faces of the cylinder are also silvered, as at 15, in continuation of the liner 13. The cylinder 14 has its outer periphery polished to be as smooth as possible and is made of a material referred to herein and in the appended claims as "an intermediate material" and in the examples of the invention herein described the intermediate material is barium titanate or barium titanate which includes, as desired, a percentage of a material such as strontium titanate, such intermediate materials being hereinafter and in the appended claims referred to as "barium titanate." The shaft 11 is engaged by an electrical brush 16 and is arranged for continuous rotation by an electric motor 17, Fig. 2.

The driven member consists of a band 18 of electrically conductive material, for example phosphor-bronze, which is looped round the cylinder 14 and provides an electrically conductive face which is engaged with the

side of the cylinder opposite the side thereof engaged by the liner 13 and which, by a brush 19 is connected with the line 10 to the pulse generator 8. The ends of the band 18 are connected at 20, 21 respectively with an actuating element 22 which is engaged by an electrically insulating cap 23 fitted over or to the end of the stylus 4 remote from the marking end 5 thereof. The cap 23 is maintained in engagement with the actuating element 22 by the spring 7 and that starting position of the element 22, that is the inactive position of the stylus 4, is determined by an adjusting screw 24 formed from electrically insulating material and supported by a bar 25 of insulating material.

The surface resistivity of the peripheral portion of the cylinder 14 which is engaged by the band 18 is retained by effecting lubrication thereof by a pad, not shown, of polytetrafluorethylene which is resiliently urged into engagement with the cylinder.

In operation of the device, the driving member 11, 12, 13, together with cylinder 14, is rotated continuously by the motor 17, or if desired from the main drive, not shown, of the machine, with a high angular velocity, which may, for example, be of the order of 4,000 R. P. M., although lower angular velocities of the order of 150 to 500 R. P. M. may be used. Any tendency for the driven member 18 to be moved with the driving member prior to energization of the electric circuit is overcome by the spring 7. The circuit is energized by a voltage pulse the waveform of which is illustrated in Fig. 3, and which is generated by the generator 8. The voltage pulse is developed across the output impedance of the generator shown as a resistor 26, Fig. 1, and is applied across the conductive faces 13 and 18. The electric stress developed between the mutually charged surfaces of the liner 13 and band 18 and the intermediate material by the positive part of the waveform causes attraction to effect locking of the driven member 18 to the driving member 11, 12 thereby to cause cessation of relative movement between the members so that the member 18 is moved positively by shaft 11 and, through actuating element 22, effects lengthwise movement of the stylus 4 against the action of spring 7 so that the marking end 5 of the stylus causes a dot to be marked on the impression-receiving material 1. On de-energization of the circuit a negative part of the voltage pulse is applied across the conductive faces 13, 18 through the output impedance 26 which acts as a shunt so causing the driven member 18 to be released from the driving member 11, 12, 13 so that the spring 7 acts to restore the actuating element 22 and stylus 4 to the starting positions thereof.

The intermediate material is described above as being barium titanate but it may be of any suitable material provided that it has a dielectric constant and thickness such that on energization of the circuit connected to the electrical conductors the electric stress developed between the above-mentioned mutually chargeable faces 13, 18 is sufficient to cause attraction such as will lock a driven member to a driving member for positive movement therewith. The resistivity of the material will, of course, be such as to prevent electrical breakdown between the conductive faces 13, 18.

In the embodiment of the invention described above the intermediate material is, as already stated, barium titanate and in one form of apparatus as described above, and illustrated in Figs. 1 and 2, and which has been successfully operated in practice, the barium titanate had a dielectric constant of 1200, the thickness of the cylinder was 0.125 in., the outside diameter of the cylinder was 1 inch, the cylinder was rotated at about 1,000 R. P. M. This apparatus was operated by pulses having a positive peak voltage value in the range of 50 v. to 200 v., and the current flowing during activation of the device was of the order of 500 micro-amperes. When the intermediate material is barium titanate the dielectric constant

may be increased to 3,000 to 5,000 by the use of suitable additives such as strontium titanate.

From the foregoing it will be readily understood that a device operating in accordance with the present invention is clearly distinguished from the prior proposal contained in the above mentioned French Patent No. 533,368 because the pulses applied across the conductors have a constant peak voltage of a value such that electric stress causes attraction which locks the driven member 18 immovably relative to the driving member whereas in the prior proposal relative movement between the conductors must be permitted at all times in order that voltage variations may be reflected by relative movement between the conductors. Thus, whereas in the prior proposal movement of the driven member is a function only of the voltage variation, in a device according to the present invention movement of the driven member is solely dependent on movement of the driving member.

In the apparatus described above the driving member is common to all of the wire-like element 4 and has co-operating therewith a driven member individual to each element 4. It will be understood, however, that where only a single mechanical element is to be operated a driving member and driven member will be provided to effect operation thereof.

Fig. 4 illustrates an embodiment of the invention adapted to act as a clutch. In this embodiment of the invention the driving member comprises a flanged boss or clutch disc 12 to the shaft 11 and the driven member comprises a disc, the equivalent of band 18, rotatable with a shaft 27. The intermediate material 14 is adhered either to disc 18 or to disc 12 and abutment between the elements is maintained by arranging that the disc 18 is movable axially of shaft 27 and is urged towards disc 12 by a spring 7 which acts against a pin 28 secured to shaft 27 and extending through a slot 29 in the boss of disc 18.

Figs. 5 and 6 illustrate one transmission element of a modified form of clutch in which the discs 12, 18 are secured to their respective shafts 11, 27 to be in fixed face-to-face relation and the intermediate material is formed as inserts located in apertures formed in the face of one of the discs. Springs 7 located in the apertures behind the inserts act to maintain alignment of the clutch.

If desired a motion transmitter of the kind described above with reference to Fig. 1 can be modified so that the shaft 11 is oscillatory instead of rotary. If so modified the mechanical element to be operated thereby can be permanently connected to the actuating element 22 to be wholly operated by the transmitter instead of being returned by a spring 7. It will be understood that the to and fro movement of the mechanical element will be maintained while the voltage across the conductors 11, 12, 13 and 18 and intermediate material 14, is maintained but that the driven member 18 will be released from the driving member 11, 12, 13, as described above when the circuit is de-energized.

Transmitter constructed in accordance with the invention may, as appropriate, be operable under control of electrical pulses as described above, by alternating current, or by direct current. Figs. 7 and 8 respectively illustrate circuits for operating a transmission device by alternating current and by direct current, and Fig. 7 shows the disposition of the discharge shunt 26 while Fig. 8 shows a switch 31 which acts in the manner of a shunt to discharge the electric stress after the direct current circuit is de-energized.

It will be readily understood that motion transmitters constructed in accordance with the present invention are applicable to a considerable number of uses and that, in particular, having regard to the art of record controlled statistical machines, such a transmitter can, as described above, be adapted to control an imprinting device or a transmitter similar to that described with reference to Figs. 1 and 2 may be adapted to effect the setting of set

bars of a punch unit, or to effect the operation of the punches of a punch unit. A clutch of the kind described with reference to Fig. 4 or to Figs. 5 and 6 can, at least in instances where the load is not excessive, be used for transmitting rotary motion.

I claim:

1. A motion transmitter comprising a continuously operable driving member and a driven member supported for relative movement along the line of movement of the driving member and each having an electrically conductive face connected in an electric circuit, means operable selectively to apply to the circuit a voltage having a constant peak value, an intermediate material having opposite sides thereof engaged one by each of the conductive faces of the driving and driven members, said material being movable with one of said members and having a dielectric constant and thickness between said opposite sides thereof such that on energisation of said circuit electric stress causes attraction to effect locking of the driven member to the driving member to cause cessation of relative movement between the members, and shunt means connected across said conductive faces to release the driven member from the driving member on the de-energisation of said circuit.

2. A motion transmitter comprising a continuously operable driving member and a driven member supported for relative movement along the line of movement of the driving member and each having an electrically conductive face connected in an electric circuit, means operable selectively to apply to the circuit a voltage having a constant peak value, a barium titanate element having opposite sides thereof engaged one by each of the conductor faces of the driving and driven members, said element being movable with one of said member and having a dielectric constant and thickness between said opposite sides thereof such that on energisation of said circuit electric stress causes attraction to effect locking of the driven member to the driving member to cause cessation of relative movement between the members, and shunt means connected across said conductor faces to release the driven member from the driving member on de-energisation of said circuit.

3. A motion transmitter comprising a band normally constrained against lengthwise movement and having an electrically conductive surface locked about and engaging smooth polished periphery of a hollow cylinder rotatable with a continuously rotatable driving shaft and having an electrically conductive interior surface, said conductive surfaces being connected in an electric circuit together with a pulse generator adapted to emit low current pulses of short duration and having a constant peak value voltage, the said cylinder being made of a material having a dielectric constant and thickness such that on energisation of said circuit by the pulse generator electric stress causes attraction to effect locking of the band to the cylinder thereby to cause lengthwise movement of the band, and shunt means connected across said conductive surfaces to permit relative movement between the band and the cylinder on de-energisation of said circuit.

4. A motion transmitter comprising a band normally constrained against lengthwise movement and having an electrically conductive surface looped about and engaging the smooth polished periphery of a hollow barium titanate cylinder rotatable with a continuously rotatable driving shaft and having an electrically conductive interior surface, said conductive surfaces being connected in an electric circuit together with a pulse generator adapted to emit low current pulses of short duration and having a constant peak value voltage, the said cylinder having a dielectric constant and thickness such that on energisation of said current by the pulse generator electric stress causes attraction to effect locking of the band to the cylinder thereby to cause lengthwise movement of the band, and shunt means connected across said conductive

surfaces to permit relative movement between the band and the cylinder on de-energisation of said circuit.

5. A motion transmitter comprising an element supported for movement against the action of a spring a band connected with said element and constrained by said spring against lengthwise movement, said band having an electrically conductive surface looped about and engaging the smooth polished peripheral surface of a hollow cylinder rotatable with a continuously rotatable driving shaft and having an electrically conductive interior surface, said conductive surfaces being connected in an electric circuit together with a pulse generator adapted to emit low current pulses of short duration and having a constant peak value voltage, the said cylinder being made of a material having a dielectric constant and thickness such that on energisation of said current by the pulse generator electric stress causes attraction to effect locking of the band to the cylinder thereby to cause lengthwise movement of the band, and shunt means connected across said conductive surfaces to permit relative movement between the band and the cylinder on de-energisation of said circuit.

6. A motion transmitter comprising an element supported for movement against the action of a spring, a band connected with said element and constrained by said spring against lengthwise movement, said band having an electrically conductive surface looped about and engaging the smooth polished peripheral surface of a hollow barium titanate cylinder rotatable with a continuously rotatable driving shaft and having an electrically conductive interior surface, said conductive surfaces being connected in an electric circuit together with a pulse generator adapted to emit low current pulses of short duration and having a constant peak value voltage, the said cylinder having a dielectric constant and thickness such that on energisation of said circuit by the pulse generator electric stress causes attraction to effect locking of the band to the cylinder thereby to cause lengthwise movement of the band and said element against the action of said spring, and shunt means connected across said conductive surfaces to permit relative movement between the band and the cylinder on de-energisation of said circuit.

7. A motion transmitter comprising an element supported for movement against the action of a spring, an actuator supported in abutting relation with said element by a band having an electrically conductive surface looped about and engaging the smooth polished peripheral surface of a hollow cylinder rotatable with a continuously rotatable driving shaft and having an electrically conductive interior surface, the ends of said band being secured to said actuator to permit movement thereof by the band against the action of said spring and the conductive surfaces being connected in an electric circuit together with a pulse generator adapted to emit low current pulses of short duration and having a constant peak value voltage, said cylinder being made of a material having a dielectric constant and thickness such that on energisation of said circuit by the pulse generator electric stress causes attraction to effect locking of the band to the cylinder thereby to cause movement of the band, the actuator, and said element against the action of said spring, and shunt means connected across said conductive surfaces to permit relative movement between the band and the cylinder on de-energisation of said circuit.

8. A motion transmitter comprising a plurality of elements supported in side-by-side relation for independent lengthwise movement against the action of springs of which one is provided for each said element, a band for each said element, each said band being an electrically conductive surface looped about and engaging the smooth polished peripheral surface of a hollow cylinder common to all said bands, said cylinder being rotatable with a continuously rotatable driving shaft and having an electrically conductive interior surface, a pulse generator

adapted to emit low current pulses of short duration and having a constant peak value voltage; said generator being connected in an electric circuit which includes a connection between the generator and the conductor surface of the cylinder and separate connections between the generator and each of the conductive band surfaces, said cylinder being made of a material having a dielectric constant and a thickness such that on energisation of the circuit by the generator electric stress causes attraction to lock to the cylinder any band the conductor surface of which has current applied thereto thereby to cause movement of such band and the element connected thereto against the action of the spring co-operating with the element, and shunt means connected across said conductive surfaces to permit restoration of active elements and of the bands connected thereto on de-energisation of said circuit.

9. A motion transmitter comprising a plurality of elements supported in side-by-side relation for independent lengthwise movement against the action of springs of which one is provided for each said element, a band for each said element, each said band having an electrically conductive surface looped about and engaging the smooth polished peripheral surface of a hollow barium titanate cylinder common to all said bands, said cylinder being rotatable with a continuously rotatable driving shaft and having an electrically conductive interior surface, a pulse generator adapted to emit low current pulses of short duration and having a constant peak value voltage, said generator being connected in an electric circuit which includes a connection between the generator and the conductive surface of the cylinder and separate connections between the generator and each of the conductive band surfaces, said cylinder having a dielectric constant and thickness such that on energisation of the circuit by the generator electric stress causes attraction to lock to the cylinder any band the conductive surface of which has current applied thereto thereby to cause movement of such band and the element connected thereto against the action of the spring co-operating with the element, and shunt means connected across said conductive surfaces to permit restoration of active elements and of the bands connected thereto on de-energisation of said circuit.

10. A motion transmitter comprising a continuously rotatable driving member, and a normally stationary rotatable driven member coaxial with the driving member and supported in face-to-face relation with the driving member for rotation thereby, the opposed faces of the driving and driven members being electrically conductive faces and connected in an electric circuit, means operable selectively to apply to the circuit a voltage having a constant peak value, an intermediate material extending between said members and engaged on opposite sides thereof by the conductive faces of the members, said material being movable with one of said members

and having a dielectric constant and thickness such that on energisation of said circuit electric stress causes attraction to effect locking of the driven member to the driving member thereby to cause rotation of the driven member by the driving member, and shunt means connected across said conductive faces to release the driven member from the driving member on deenergisation of said circuit.

11. A motion transmitter comprising a continuously rotatable driving member, a normally stationary rotatable driven member co-axial with the driving member and supported in face-to-face relation with the driving member for rotation thereby, the opposed faces of the driving and driven members being electrically conductive faces and connected in an electric circuit, means operable selectively to apply to the circuit a voltage having a constant peak value, a barium titanate element being rotatable with one of said members, extending between said member and engaged on opposite sides thereof by the conductive faces of the members, said element having a dielectric constant and thickness such that on energisation of said circuit electric stress causes attraction to effect locking of the driven member to the driving member thereby to cause rotation of the driven member by the driving member, and shunt means connected across said conductive faces to release the driven member from the driving member on de-energisation of said circuit.

12. A motion transmitter comprising a continuously rotatable electrically conductive driving disc, a normally stationary rotatable electrically conductive driven disc co-axial with the driving disc and supported in face-to-face relation with the driving disc for rotation thereby, said discs being connected in an electric circuit, means operable selectively to apply to the circuit a voltage having a constant peak value, barium titanate elements located in apertures formed in the face of one of said discs and spring urged into engagement with the face of the other of the discs, said elements having a dielectric constant and thickness such that on energisation of said circuit electric stress causes attraction to effect locking of the driven disc to the driving disc thereby to cause rotation of the driven disc by the driving disc, and shunt means connected across said conductive discs to release the driven disc from the driving disc on de-energization of said circuit.

References Cited in the file of this patent

UNITED STATES PATENTS

1,631,764	Ruben	June 7, 1927
2,148,482	Lorenz	Feb. 28, 1939
2,630,512	Rahbek	Mar. 3, 1953

FOREIGN PATENTS

481,446	Germany	Aug. 26, 1929
533,368	France	Dec. 8, 1921