Dec. 8, 1959 A. HUFNAGEL 2,916,582

TIMING RELAYS

Filed Sept. 16, 1958 2 Sheets-Sheet 1

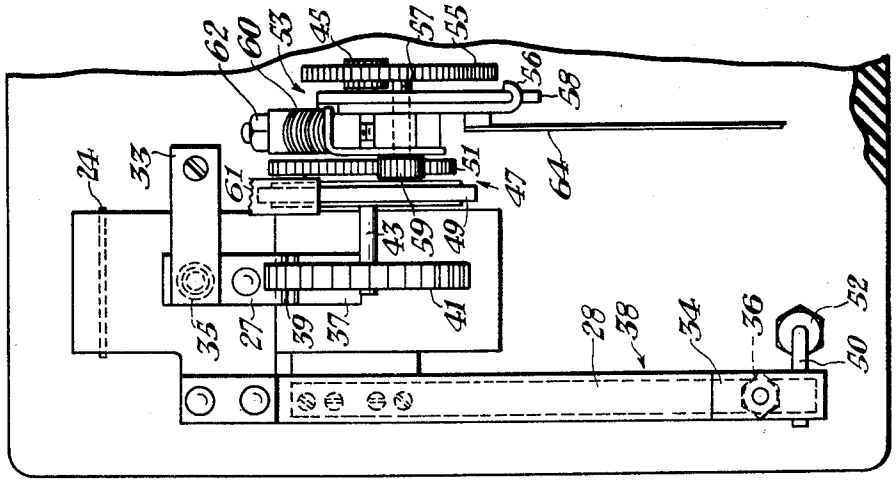


Fig. 2.

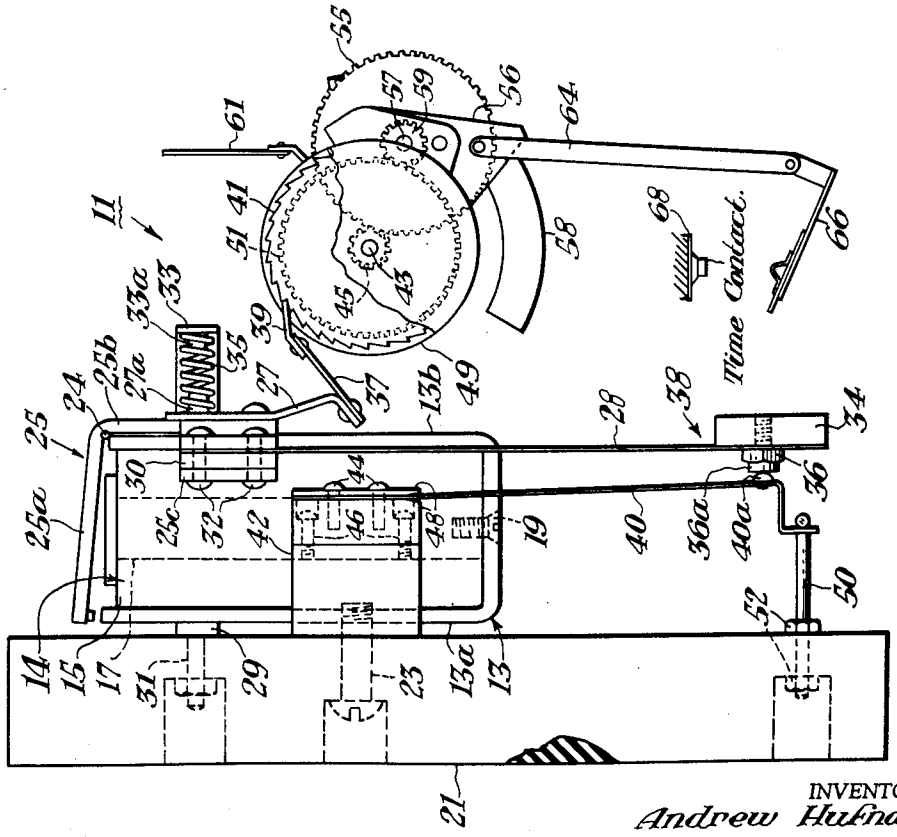


Fig. 1.

INVENTOR.
Andrew Hufnagel.
BY
W. L. Stout.
HIS ATTORNEY

Dec. 8, 1959 A. HUFNAGEL 2,916,582

TIMING RELAYS

Filed Sept. 16, 1958 2 Sheets-Sheet 2

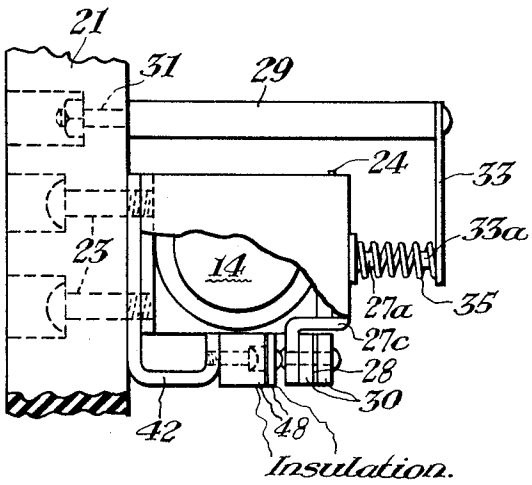


Fig. 3.

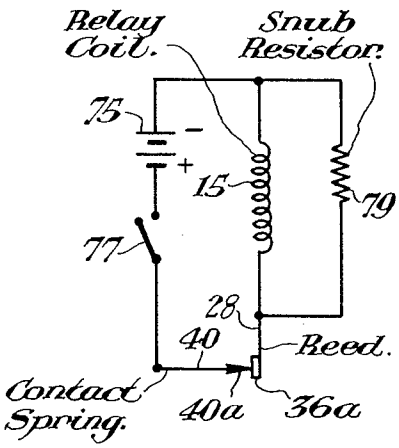


Fig. 5.

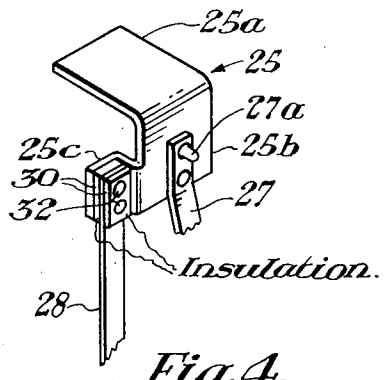


Fig. 4.

INVENTOR.
Andrew Hufnagel.
BY
W. L. Stout.
HIS ATTORNEY

United States Patent Office 2,916,582 Patented Dec. 8, 1959

2,916,582

TIMING RELAYS

Andrew Hufnagel, Penn Hills Township, Allegheny County, Pa., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

Application September 16, 1958, Serial No. 761,435

9 Claims. (Cl. 200—97)

My invention relates to timing relays, and more particularly to relays of the type comprising a contact which becomes closed at the expiration of a time interval of relatively long duration after the relay becomes energized.

An object of my invention is the provision, in a relay of the foregoing type, of novel means for maintaining constant the time required to close the time contacts irrespective of variations in the source of voltage supplying the relay and irrespective of variations in the ambient temperature.

In the attainment of the foregoing object I provide a self-timing relay including an operating coil, an armature operable in response to the energization of the operating coil, an oscillating pendulum operatively connected to the armature and said pendulum in turn controlling the energization of the armature. A timing mechanism actuated by the armature movement is effective to close a contact after a predetermined time interval.

Other objects and advantages of my invention will become apparent from the following description and the accompanying drawings in which:

Fig. 1 is a side elevational view of a relay in accordance with my invention;

Fig. 2 is a front elevational view of the relay of Fig. 1;

Fig. 3 is a plan view of the relay of Fig. 1;

Fig. 4 is an enlarged isometric view of a portion of the armature of the relay of Fig. 1; and,

Fig. 5 is a schematic diagram of a portion of the electric circuitry for the relay of Fig. 1.

I shall first describe one embodiment of my invention and shall then point out the novel features thereof in the appended claims.

Referring to the drawings, timing relay **11** includes a U-shaped backstrap **13** which receives an electromagnet or stepping magnet **14** consisting of an operating coil winding **15** mounted on a central core **17**, which core is affixed to backstrap **13** as by a screw **19**. Backstrap **13** is in turn affixed to relay base **21** as by screws **23**. An L-shaped armature **25** is pivotally mounted on pin **24** welded on the free end of leg **13***b* of backstrap **13** to permit the inner angle of the armature to rock with respect to leg **13***b* of backstrap **13**. One leg **25***a* of armature **25** extends transversely across the end of core **17**, and the other leg **25***b* extends downwardly adjacent leg **13***b* of backstrap **13**. A depending arm **27** is affixed to leg **25***b* of armature **25**.

A hollow rod **29** is mounted on base **21** as by bolt **31**. As best seen in Fig. 3, a lateral extension **33** mounted on rod **29** by bolt **31** retains a coil spring **35** in position to bias armature **25** to a normally nonattracted or open position, that is, with the leg **25***a* separated from the end of core **17**. A button **33***a* formed on the end of extension **33**, and a button **27***a* formed on arm **27** hold spring **35** in position.

As best seen in Fig. 4, a projection **25***c* is formed on leg **25***b* of armature **25**. One end of a downwardly extending reed **28** of suitable conductive material is disposed between a pair of insulative blocks **30** and affixed to projection **25***c* as by rivets **32**. Suitable insulative bushings, not shown, are interposed between rivets **32** and the apertures in reed **28**. A weight **34** is secured as by a screw **36** to the lower end of the reed **28**. A contact button **36***a* is welded on the head of screw **36**. An electrical lead, indicated schematically in Fig. 5, is connected to reed **28**. Reed **28** and weight **34** form a compound pendulum **38** whose oscillating frequency is essentially fixed by factors such as gravity, the mass of the weight **34**, the stiffness of reed **28**, and the stiffness of the member, here a contact **40***a* mounted on a spring **40**, which contact button **36***a* engages.

One end of the leaf type contact spring **40**, of suitable conductive material, is mounted on a J-shaped back plate **42**, see Fig. 3, which plate is in turn mounted between leg **13***a* of backstrap **13** and base **21**. Spring **40** is affixed to plate **42** as by screws **44** and **46** extending through insulative blocks **48**. As best seen in Fig. 1, in order to insulate spring **40** from the remainder of the relay, spring **40** is initially affixed between insulative blocks **48** by screws **44** and then this assembly is in turn affixed by screws **46**, spaced from screws **44**, to plate **42**. An electrical lead, indicated schematically in Fig. 5, is connected to spring **40**.

Spring **40** is formed and mounted to be strongly biased toward reed **28**. Contact button **40***a* on the lower end of spring **40** normally closes or engages contact **36***a* when relay **11** is deenergized. The extreme lower end of spring **40** is bent and arranged to engage an L-shaped stop member **50** which is affixed to base **21** by nuts **52**. Stop **50** is arranged to position spring **40** approximately parallel to reed **28**, that is, stop **50** limits any movement of spring **40** toward reed **28**. Stop **50** also limits any excessively large amplitude swings of pendulum **38** toward spring **40**, as will be explained hereinbelow.

The details of the gearing assembly are similar to those shown and discussed in Patent No. 1,966,965, issued on July 17, 1934 to B. Lazich and H. E. Ashworth, now expired, and which patent is assigned to the same assignee as the present invention. Therefore, for present purposes, only a brief description of the gearing assembly will suffice for an understanding of the operation of my relay.

One end of a leaf spring **37** is affixed as by rivets to the lower end of an arm **27** and a pawl **39** is affixed to the other end of spring **37**. Pawl **39** engages a ratchet wheel **41** affixed on the end of a rotatable shaft **43**. A spur gear **45** is affixed on the opposite end of shaft **43**, see Fig. 2. A clutch assembly **47** including a clutch wheel **49** and a spur gear wheel **51** is rotatably mounted intermediate the ends of shaft **43**. A planetary gear assembly **53** is rotatably mounted on shaft **43** at a point between clutch assembly **47** and spur gear **45**. Spur gear **45** operatively meshes with a spur gear **55** which is affixed on one end of a countershaft **57** of planetary assembly **53**. A sun gear **59** affixed on the opposite end of countershaft **57** engages a gear wheel **51** of clutch assembly **47**. Sun gear **59** rotates about wheel **51** when a brake arm **61** is actuated by means, not shown, to drop against or engage wheel **49** of clutch assembly **47** to hold the clutch assembly including gear wheel **51** stationary. An index plate **56** is affixed to gear assembly **53** and is rotated by the movement of sun gear **59** around wheel **51**. Link member **64** carrying a movable timing contact **66** is affixed to plate **56**. A timing segment **58** is movably positioned with respect to plate **56** by interval adjusting worm **60** and locked by nut **62**. Adjustment by worm **60** of segment **58** with respect to plate **56** determines the initial spacing between the movable contact **66** and a stationary timing

contact 68 and thus the time interval between actuation of the brake 61 and the closing of the timing contact 68. When the timing contacts 66 and 68, close, a separate contact, not shown, is opened to cause relay 11 to be deenergized. When brake 61 is actuated to disengage clutch wheel 49, planetary assembly 53 returns to its initial position due to gravity in preparation for the next timing operation.

Fig. 5 shows a schematic diagram of a portion of the electrical circuitry of the relay 11. A source of potential here shown as a battery 75 is connected to the operating coil 15 of relay 11 over a circuit which may be traced from the positive terminal of battery 75, through a suitable energizing switch 77, contact spring 40 and contact buttons 40*a* and 36*a*, reed 28, and coil 15 to the negative terminal of battery 75. A snubbing resistor 79 is connected in parallel with coil 15 to suppress contact arcing and to control the pickup and release time of the relay. As will presently be explained, the energy imparted to pendulum 38 by movement of the armature 25 is substantially constant.

It has been experimentally found that by properly selecting the value of resistor 79 with respect to the impedance of coil 15 a maximum energy can be imparted to the pendulum at a normal operating voltage. Further, a resistor selected for purposes of causing maximum energy to be imparted to the pendulum at normal voltages is also effective, at relatively higher voltages, to limit the amplitude of oscillations of the pendulum. It has thus been found possible to operate the timing relay over a wide range of voltages, in one embodiment from 13 to 32 volts, with the frequency being the same at both extremes of voltage and a maximum of 2% higher at some intermediate voltage.

The operation of relay 11 is substantially as follows: When switch 77 is closed, coil 15 will be energized over the circuit previously traced causing armature 25 to move to its attracted position. Movement of armature 25 moves reed 28 affixed thereto to the right, as oriented in Fig. 1, and thus imparts mechanical energy to pedulum 38 causing said pendulum to swing to the right, and thereby to disengage or open the contacts 36*a* and 40*a*. Coil 15 is then deenergized and its flux field will decay. Armature 25 will then be returned to its nonattracted position by the force of the biasing spring 35. This second movement of armature 25 imparts additional mechanical energy to pendulum 38 and said pendulum reverses its direction of oscillation and moves to the left toward engagement with spring 40. With contacts 40*a* and 36*a* closed, coil 15 will again be energized and the cycle of operation will be repeated.

The movement of armature 25 between its attracted and nonattracted positions causes arm 27 mounted on the armature to actuate pawl 39 which engages and drives the ratchet wheel 41, shaft 43 and gear 45. When a timing operation is initiated by the actuation of brake 61, clutch wheel 49 is braked and clutch assembly 47 including gear wheel 51 is held stationary. Pinion gear 45 on shaft 43 turns spur gear 55 and causes the countershaft 57 and pinion 59 to rotate. Since gear wheel 51 is stationary, sun gear 59 rotates or climbs around gear wheel 51. The rotation of sun gear 59 causes the planetary assembly 53 including spur gear 55, index plate 56 and link member 64 to rotate counterclockwise as oriented in Fig. 1. Movable timing contact 66 is then moved toward stationary timing contact 68 at a constant predetermined rate. The timing interval is controlled by the initial spacing between contacts 66 and 68 as determined by adjusting worm 60. When the timing contacts 64 and 66 close, a separate contact, not shown, deenergizes relay 11 to stop the stepping action. The planetary assembly 53 remains in a position corresponding to the closed position of the timing contacts until brake arm 61 is released, by external means. When brake 61 is released the planetary assembly 53 returns to its initial position under the influence of gravity in readiness to complete a new timing operation.

Pendulum 38 receives energy due to each movement of the armature of relay 11. Initially the amplitude of the swing of pendulum 38 will increase until the energy imparted thereto by armature 25 is equal to the energy dissipated in the pendulum due to mechanical hysteresis, windage, and friction of the contact buttons 40*a* and 36*a*. It will be appreciated that the actual amounts of energy involved are quite small.

The relay coil 15 is energized at a relatively high level, and armature 25 has a stiff biasing spring 35 so that the operating or movement time of the armature is relatively short with respect to the period or time of the pendulum swing. Since the armature 25 operates quickly and with a stroke of fixed length, the mechanical energy imparted to the reed 28 at each stroke is substantially constant irrespective of operating voltage or ambient temperature. Thus the oscillating frequency of pendulum 38 is affected by the stroke and operating time of the armature 25 only to the extent that a relatively small amount of mechanical energy is being imparted to the reed to keep the pendulum swinging. Since the operating frequency of the coil 15 and armature 25 is in turn determined by the pendulum actuated contact 36*a* actuating contact 40*a*, the frequency of operation of the coil and armature must also remain constant.

Stop 50 is an included safety factor. Any lessening of friction losses or increase in stroke of the armature might possibly build the amplitude of the pendulum swing to a point of eventually damaging reed 28 or contact spring 40. Stop 50 is therefore added to limit excessive swings of the pendulum 38, but it is located at such a distance that it has only a minor influence on the normal free swinging characteristics of the pendulum. Stop 50 is nonresilient such that should reed 28 strike the stop enough energy is absorbed to limit the swing of the pendulum 38 in both directions.

While my invention has been described with reference to a particular embodiment thereof, it will be understood that various modifications can be made by those skilled in the art without departing from the invention. The appended claims are therefore intended to cover such modifications within the true spirit and scope of the invention.

Having thus described by invention, what I claim is:

1. A relay including a stepping mechanism for closing a contact after the expiration of a predetermined time interval following the initial energization of said relay comprising, an electromagnet, an armature movable between a biased nonattracted position and an attracted position in response to the energization of said electromagnet, said armature arranged to actuate said stepping mechanism, an arm carrying a first electrical contact, and a pendulum carrying a second electrical contact, said pendulum being urged to oscillation by the movement of said armature, said pendulum oscillating between engaging and nonengaging positions of said first and second contacts, whereby said electromagnet is arranged to be periodically energized by a circuit completed through said contacts.

2. In a self-timing relay having a timing contact which is closed after the expiration of a predetermined time interval following the initial energization of said relay, the combination of a stepping magnet including an electrical circuit therefor, an armature movable between an initially biased nonattracted position and an attracted position in response to the energization of said stepping magnet, a resilient contact member in the electrical circuit of said stepping magnet, a pendulum including a resilient arm and an electrical contact, said pendulum being operatively connected to said armature and oscillating at its natural frequency as energy is imparted thereto by movement of said armature, said pendulum and its electrical contact cooperating with said resilient contact

member to control the timing of the energization of said stepping magnet, and means actuated by said armature for closing said timing contact.

3. A timing relay comprising an electromagnet arranged to be energized from a source of potential, an armature operatively connected with said electromagnet and movable from a first to a second position as said electromagnet is energized, a resilient contact member in the electrical circuit of said electromagnet, a pendulum including a resilient arm and carrying an electrical contact, said pendulum being operatively connected with said armature and being periodically urged to oscillation at its natural frequency as said armature moves between its said positions, said electrical contact on said pendulum cooperating with said contact member for periodically connecting said electromagnet to its source of potential whereby the natural period of oscillation of said pendulum is unaffected by the operating characteristics of said armature.

4. A timing relay comprising an electromagnet arranged to be energized from a source of potential, an armature operatively connected with said electromagnet and movable from a first to a second position as said electromagnet is energized, a resilient contact member in the electrical circuit of said electromagnet, a pendulum including a resilient arm and carrying an electrical contact, said pendulum being operatively connected with said armature and being periodically urged to oscillation at its natural frequency as said armature moves between its said positions, said electrical contact on said pendulum periodically engaging said contact member for connecting said electromagnet to its source of potential, said resilient arm of said pendulum and said resilient contact member cooperating to dissipate a portion of the oscillation energy of said pendulum to control the amplitude of the oscillations of said pendulum, and a stop member arranged to position said resilient contact member relative to the unoperated position of said pendulum and arranged to limit the amplitude of oscillations of said pendulum.

5. In a self-timing relay having a timing contact which is closed after the expiration of a predetermined time interval which remains constant irrespective of the operating voltage of the relay or ambient temperature, the combination comprising an electromagnet arranged to be energized by a source of potential, an armature operatively connected with said electromagnet and movable relative thereto between an initially biased nonattracted position and an attracted position as said electromagnet is energized, a contact member in the electrical circuit of said electromagnet, a pendulum including a resilient arm carrying a first contact operatively connected with said armature and oscillating in response to the movement of said armature, said pendulum cooperating with said contact member for completing a circuit for energizing said electromagnet, and means actuated by said armature in moving between its positions for closing said timing contact.

6. In a self-timing relay, the combination comprising an electromagnet arranged to be energized by a source of potential, an armature movable between an initially biased first position and a second position in response to the energization of said electromagnet, an arm carrying a first contact connected in the electrical circuit of said electromagnet, a pendulum including a resilient arm carrying a second electrical contact, said pendulum being operatively connected to said armature and oscillating in response to the movement of said armature, said pendulum cooperating with said arm for completing an energizing circuit for said electromagnet, a timing contact, stepping means operatively connected to said contact and said armature and actuated due to movement of said armature, and said stepping means being effective to close said timing contact after the expiration of a predetermined time interval following the initial energization of said electromagnet.

7. In a self-timing relay the combination of a stepping magnet arranged to be energized by a source of electric potential, an armature movable relative thereto between an initial position and a second position in response to the energization of said stepping magnet, a timing contact, stepping means operatively connected with said armature and actuated by movement of said armature for engaging said contact after the expiration of a predetermined time interval following the initial energization of said stepping magnet, a first contact carrying member connected in the electrical circuit of said stepping magnet, a pendulum including a resilient arm carrying a second contact operatively connected with said armature and having oscillatory motion in response to movement of said armature and between engaging and nonengaging positions of said first and second contacts, and said pendulum cooperating with said contact member in said engaging position for completing an energizing circuit for said stepping magnet whereby said timing means are stepped for closing said timing contact.

8. In a self-timing relay, the combination of electromagnetic means, an armature movable between an initial position and a second position in response to the energization of said electromagnetic means, a contact member, a pendulum operatively connected to said armature and adapted to cooperate with said contact member, an electrical circuit controlled by said pendulum and said contact member for connecting said electromagnetic means to a source of energy, and stepping means actuated by said armature following the initial energization of said electromagnetic means.

9. In a self-timing relay, the combination of an electromagnet and an armature movable between a nonattracted position and an attracted position in response to the energization of said electromagnet, a spring biasing said armature to said nonattracted position, a pawl operatively connected to said armature and actuated by movement of said armature, a gear train including a rotatable clutch assembly, a planetary gear assembly, means for braking said clutch assembly, said planetary assembly arranged to rotate about said clutch assembly in response to the continued actuation of said gear train when said clutch assembly is braked, timing contacts arranged to be closed by said planetary assembly after said planetary assembly has rotated about said clutch assembly for a predetermined distance following the initial energization of said electromagnet, a pendulum affixed to said armature and arranged to be actuated thereby, said pendulum including a reed having a weight and a first contact secured thereto, a flexible arm including a second contact, an electrical circuit for energizing said electromagnet being completed through said first and second contacts, said pendulum cooperating with said flexible arm so that said first contact engages said second contact for energizing said electromagnet, and a stop member arranged relative to said flexible arm and pendulum for positioning said flexible arm and limiting the amplitude of oscillation of said pendulum.

References Cited in the file of this patent

UNITED STATES PATENTS

1,622,044	Miller et al.	Mar. 22, 1927
1,844,169	Livingston	Feb. 9, 1932
1,966,965	Lazich et al.	July 17, 1934
2,653,200	Foster et al.	Sept. 22, 1953