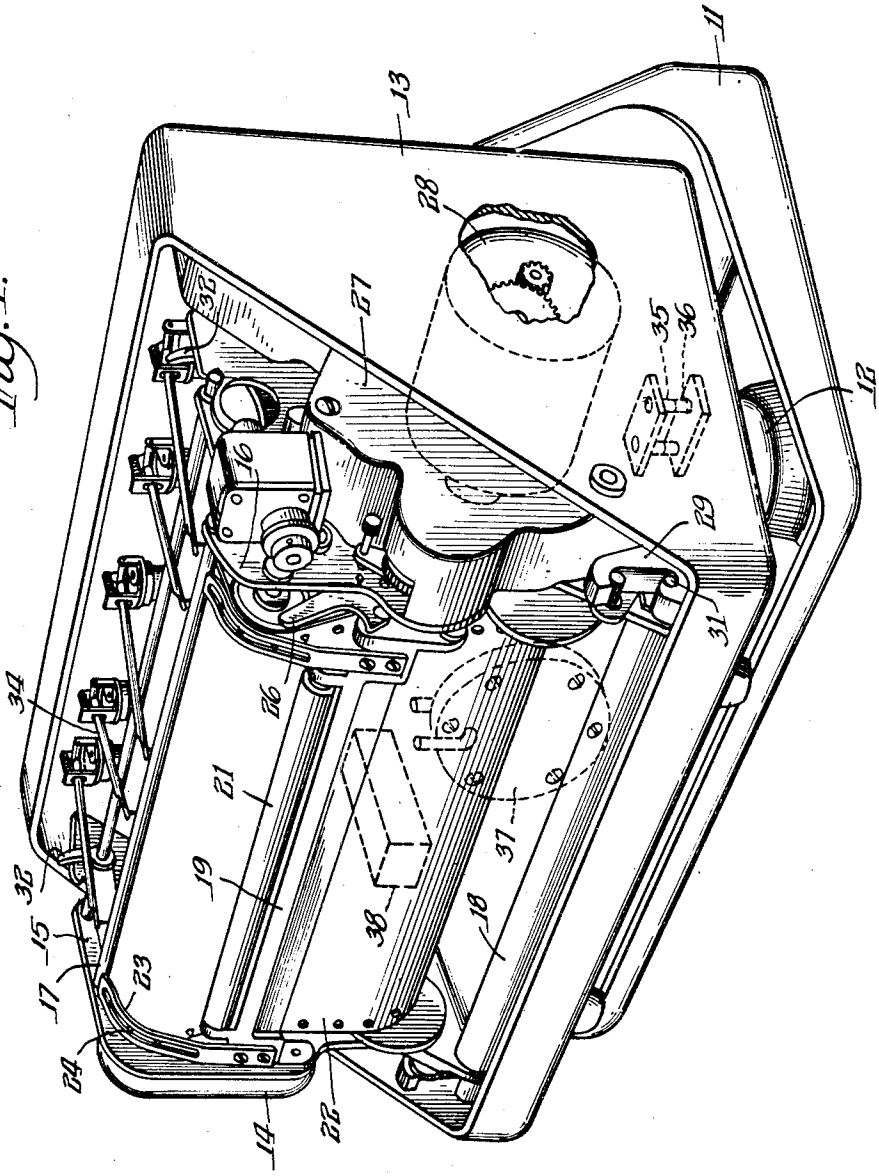
Feb. 8, 1949. C. M. HATHAWAY 2,461,322

RECORDING APPARATUS

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Fig. 1.



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Fig. 3.

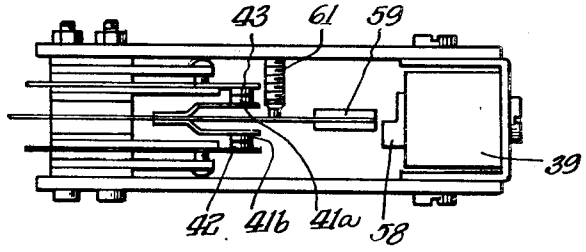
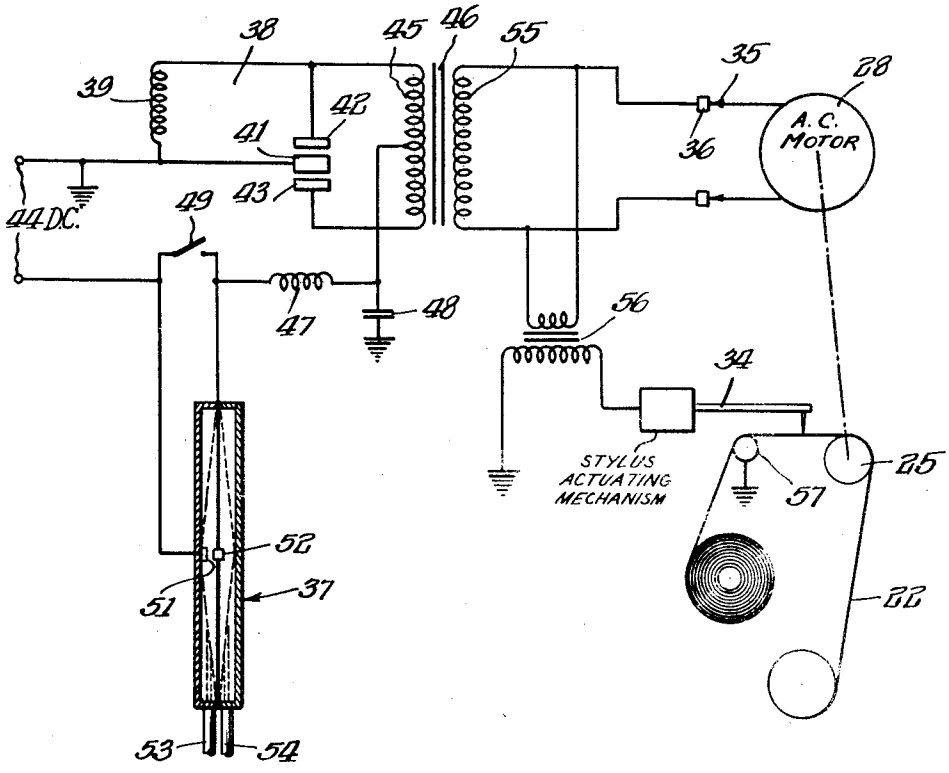


Fig. 2.



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RECORDING APPARATUS

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Application September 13, 1945, Serial No. 616,107

4 Claims. (Cl. 346—33)

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The present invention relates to recording apparatus, and more particularly to a recording apparatus such as a flight analyzer and the method of and circuit for controlling its operation.

In the operation of aircraft it is desired to obtain a record of certain factors encountered during the operation of such craft such as acceleration, air speed, altitude and other variable factors encountered during flight. To record such variable factors a recording apparatus preferably should be provided which is relatively compact and yet rugged so as to withstand shocks normally encountered during the flight of the aircraft. The record material should be driven at a constant speed, and the motor for driving such record should be capable of operation from available power sources. It is furthermore desired to have the recording apparatus begin operation after take-off and to cease operation prior to landing.

In accordance with the present invention the foregoing objectives are obtained by recording apparatus which includes a plurality of styli for making a permanent record on a record chart which is driven from a synchronous motor which has constant speed characteristics. The motor is energized from the available source of power which is direct current, through a synchronous inverter. Control of the power supply to the inverter is obtained by a pressure responsive switch which responds to a predetermined speed of the flight of the aircraft. Upon obtaining a minimum speed the switch is so operated that the circuit is closed, and upon a reduction to the same minimum speed, the circuit is again opened.

It therefore is an object of the present invention to provide an improved recording apparatus which is automatic in operation.

It is a still further object of the present invention to provide an improved recording apparatus and circuit therefor for initiating and stopping the recording of various variable factors encountered in the flight of aircraft.

Other and further objects of the present invention subsequently will become apparent by reference to the following description taken in connection with the accompanying drawings wherein—

Figure 1 is a perspective view of a recording apparatus serving as a flight analyzer embodying the present invention;

Figure 2 is a circuit diagram for controlling the operation of the recording apparatus shown in Figure 1; and

Figure 3 is a top view of a synchronous vibrator inverter element used in the circuit of Figure 2.

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A recording apparatus serving as a flight analyzer is shown in Figure 1 in perspective with the cover removed from the cabinet. This apparatus is provided with a mounting bracket 11 which may be secured to the fuselage of an aircraft. The mounting bracket 11 is provided with a plurality of resilient supports 12 which carry a cabinet 13. The resilient supports 12 preferably are arranged so that if needed the cabinet 13 may be removed from the support 11. The cabinet 13 contains a removable record chart apparatus 14 so that at the end of a flight or when an aircraft is being serviced, the chart apparatus may readily be removed for removal of the record or chart and for replenishing the supply of chart material. This arrangement is provided since it is desired to mount the bracket 11 and the cabinet 13 in an out-of-the-way place in the aircraft which might be in such position that it otherwise might be inconvenient to remove and replace the record chart. The removable chart apparatus 14 consists of a pair of end plates 15 and 16 interconnected by a plurality of rods such as the rods 17, 18 and a transversely arranged bar 19. The bar 19 carries an idler roller 21 which bears against the chart material or paper 22. The member 19 also carries a pair of clips 23 having suitable apertures for engagement of the paper on either side of sprockets 24 provided in the record chart driving roller 25 schematically shown in Figure 2. The idler roller 21 and the clips 23 may be moved outwardly by the release of a suitable catch 26. The chart or record material driving roller 25 is driven by a plurality of gears contained in a gear box 27 which are driven by an electric motor 28. The motor 28 is secured to the removable record chart apparatus 14. This apparatus 14 is supported adjacent the lower portion of the cabinet 13 in a plurality of C-shaped brackets 29 adapted to receive outwardly projecting cylinder stud members 31 carried by or attached to the end plates 15 and 16. The upper end of the chart carriage 14 is locked into position by suitable apparatus which may be released by the manual actuation of the release latch levers 32. The various features of the removable record chart apparatus 14 are described and claimed with greater particularity in the copending application entitled "Recording apparatus," Serial No. 610,462, filed Aug. 13, 1945.

The cabinet 13 contains a plurality of devices each responsive to a different variable factor such as acceleration, altitude and air speed. In addition, a plurality of electromagnetically controlled

styli may be provided for response to other apparatus in the aircraft by suitable electric connection therewith. For example, the operation of certain engine controls or variable factors of the engine may thus be recorded. In the particular embodiment shown the three centrally located styli **34** are directly actuated from apparatus contained within the cabinet **13**. The two end styli **34** are electromagnetically controlled in response to other variable factors outside of the cabinet **13**. The styli **34** normally engage the surface of the record chart material **22** which is a paper having on the inside an electrically conductive coating. A potential is applied between the coating on the under surface of the chart material at the styli **34** to cause the surface of the material to be so changed as to make a permanent record trace. A paper of this type is commercially available under the name, "Teladeltos".

Since the record chart driving motor **28**, which is of the synchronous alternating current type, is mounted upon the removable record chart apparatus **14**, the chart apparatus carries a pair of electric contacts **35** arranged for cooperation with a pair of stationary contacts **36** which are carried by the cabinet **13**. The cabinet **13** also contains a pressure responsive switch **37** which is arranged to be responsive to a predetermined minimum air speed before the switch closes. Upon a reduction of the air speed to the same minimum value, the switch **37** will open its contacts. A switch of this type is shown, described and claimed in greater detail in my copending patent application for an "Air pressure switch," Serial No. 594,725, filed May 19, 1945. The cabinet **13** also contains a synchronous inverter **38** of the vibrating reed type indicated by the rectangular dotted line enclosure in Figure 1.

The circuit diagram for the control of the recorder, as shown in Figure 1, is shown in Figure 2. The vibrating synchronous inverter includes an energizing coil **39**, a vibrating contact **41** and a pair of stationary contacts **42** and **43**. A pair of terminals **44** are provided for connection to a suitable source of direct current. One of the terminals **44** is grounded and is connected to the common juncture of the magnetic coil **39** and the movable vibrating contact **41** of the synchronous inverter **38**. The stationary contacts **42** and **43** are connected to the outer extremities of a center tap primary winding **45** of a transformer **46**. A center tap of the primary winding **46** is connected through a choke coil **47** to one contact of a pressure responsive switch **37**. The juncture between the choke coil **47** and the center point of the primary winding **45** may be bypassed to ground by a suitable by-pass capacitor **48**. The other terminal **44** is connected to the other side of the pressure operated switch **37**. A manually operable switch **49** is connected in parallel to the pressure responsive switch **37** for the purpose of testing the operation of the recording apparatus shown in Figure 1.

The pressure switch **37** has a stationary contact **51** arranged for cooperation with a movable contact **52**. The movable contact **52** is mounted on the diaphragm in a chamber so as to divide the chamber into two compartments. The two compartments are connected to suitable tubes **53** and **54** which are connected by pipes or conduits to the air pressure responsive device located adjacent the exterior of the fuselage of the plane.

The secondary winding **55** of the transformer **46** is connected to the stationary contacts **36** which

cooperate with the removable contacts **35** to complete a circuit to the alternating current synchronous motor **28**. The secondary winding **55** also supplies energy to a step-up transformer **56** having a secondary winding which is grounded at one terminal. The other terminal is connected to each of the styli **34** so that when the styli are moved in a horizontal plane in response to the electromagnets or the various instruments responsive to air speed, acceleration and the like, a permanent record will be formed on the surface of the paper **22**. A circuit therefore is completed through the secondary winding of the transformer **56** by way of the styli **34** and a grounded roller **57** which is a part of the removable chart carriage **14**.

The synchronous vibrator **38** is shown in Figure 3 and includes an energizing coil **39** which has a pole piece **58** arranged for cooperation with a movable armature **59**. The movable armature **59** is connected to a vibrating contact **41** of Figure 2. The movable contact **41** is formed in two portions **41***a* and **41***b* as may be seen in Figure 3 for cooperation with the stationary contacts **42** and **43**. A limit stop **61** is provided for the member which carries the vibrator armature **59** and the movable contacts **41***a* and **41***b*.

In the operation of the aircraft direct current is supplied to the terminals **44** of Figure 2 which energizes the vibrator synchronous inverter **38** and supplies energy to the primary winding **45** of the transformer **46** so that 60-cycle alternating current is obtained at the secondary winding **55**. The circuit to synchronous inverter **38** is completed only after the aircraft has taken off and has reached a certain minimum speed, such as, for example, sixty miles per hour. When such speed has been obtained, the differential air pressure supplied by the tubes **53** and **54** to the chamber of the air switch **37** is sufficient to move the movable contact **52** against the stationary contact **51**. Any speed in excess of the minimum speed holds the two contacts together so that the synchronous inverter **38** continues to supply energy to the transformer **46**. When the aircraft lands, a reduction of speed to substantially sixty miles per hour or slightly less, will cause the diaphragm of the pressure switch **37** to move the contact **52** to open circuit position, thereby stopping the energization of the synchronous inverter **38**.

As long as the synchronous inverter **38** supplies 60-cycle alternating power to the secondary winding **55** of the transformer **46**, the alternating current motor **28** is energized. This motor, which is connected by suitable gears in the housing **28**, drives the record chart material **22** past the various styli **34**. The speed at which the record material is moved past the various styli is constant during the operation, the desired speed having been selected by suitable gear changes in the gear box **27**. As long as the transformer **46** receives energy, high potential energy is supplied by the transformer **56** to the styli **34** so that a permanent record is electrically formed upon the chart material **22**.

Thus, for a flight analyzer it is readily appreciated that there has been provided an arrangement which automatically starts and stops the recording of various variable factors encountered during the flight of an aircraft. There is no possibility of a failure to obtain the necessary data as might be the case if the device were not operated automatically. By arranging for the automatic starting of the apparatus only after a

predetermined air speed of the craft has been obtained, there is a saving of chart material which otherwise might be used during the warming up period or during the periods where the aircraft stops at various stations along its route. By ceasing to make records during these stops, a smaller supply of record material need be carried by the aircraft, thereby holding to a minimum the total weight of the recording apparatus.

While for the purpose of illustrating and describing the present invention, a preferred embodiment has been shown in the drawings, it is to be understood that such variations are contemplated in the instrumentalities employed and in the circuit arrangement utilized as may be commensurate with the spirit and scope of the invention defined in the following claims.

The invention is hereby claimed as follows:

1. An apparatus for recording variable factors in an aircraft comprising a source of direct current, a synchronous inverter vibrator adapted to be energized from said source of direct current, a transformer energized from said synchronous inverter vibrator, a synchronous alternating current motor connected to said transformer, a record chart apparatus connected to said alternating current motor, said record chart apparatus being adapted to receive a supply of record chart material having one surface coated with electrically conductive material, a stylus connected to means moved in response to a variable factor to be recorded, a circuit extending from said record chart apparatus to said stylus including a step-up transformer, means connecting said step-up transformer for energization thereby to said first mentioned transformer, and a pressure responsive switch interconnecting said source of direct current with said synchronous inverter vibrator, said pressure responsive switch being arranged to control the starting and stopping of said recording apparatus in accordance with predetermined speeds of said aircraft.

2. A recording apparatus responsive to a plurality of variable factors in an aircraft including a record chart driving mechanism, a synchronous alternating current motor for driving said mechanism at a constant speed, a source of direct current, means interconnected between said source of direct current and said synchronous alternating current motor including a vibrator and a transformer for converting said direct current into alternating current of substantially constant frequency, and a speed responsive switch connected between said source of direct current and said vibrator, said switch being arranged to close when a predetermined value of speed has been reached and to open whenever the speed drops below a predetermined value.

3. An apparatus for recording variable factors in an aircraft comprising a source of direct current, a synchronous inverter energized from said source for supplying substantially constant frequency alternating current, a synchronous motor energized by said inverter, a record chart apparatus connected to said motor, said apparatus having a metal roller adapted to receive a supply of record chart material having one surface coated with an electrically conductive material, a stylus for cooperation with said material and said roller, means for moving said stylus in response to a variable factor to be recorded, an electrical circuit extending between said roller and said stylus and including a high voltage transformer energized from said inverter, and an aircraft speed responsive switch connected between said direct current source and said inverter, said switch being arranged to close when a predetermined value of speed has been reached by said aircraft and to open whenever the speed of said aircraft drops to a predetermined value.

4. A recording apparatus responsive to a plurality of variable factors in an aircraft including a record chart driving mechanism, a synchronous alternating current motor for driving said mechanism at a constant speed, a source of direct current, a synchronous vibrator and a transformer connected between said source of direct current and said synchronous alternating current motor for converting said direct current into alternating current of substantially constant frequency, and a fluid pressure responsive switch having a pair of electric contacts connected in series between said source of direct current and said vibrator to control the energization of said vibrator, said switch being arranged to close said contacts whenever a predetermined fluid pressure value has been reached and to open said contacts whenever fluid pressure drops below a predetermined value.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
418,391	Stone	Dec. 31, 1889
688,184	Lee	Dec. 3, 1901
921,398	Henderson et al.	May 11, 1909
1,196,335	Clokey	Aug. 29, 1916
1,444,886	Rounds	Feb. 13, 1923
1,506,807	Duncan	Nov. 25, 1924
1,902,650	Legg	Mar. 21, 1933
1,979,326	Harter	Nov. 6, 1934
2,035,474	Hay	Mar. 31, 1936
2,090,531	Hardin	Aug. 17, 1937
2,172,511	Johnson	Sept. 12, 1939
2,384,513	Wise	Sept. 11, 1945