Sept. 24, 1940. B. D. HAMMER 2,215,925

SOUND RECORDING

Filed March 29, 1937 4 Sheets-Sheet 1

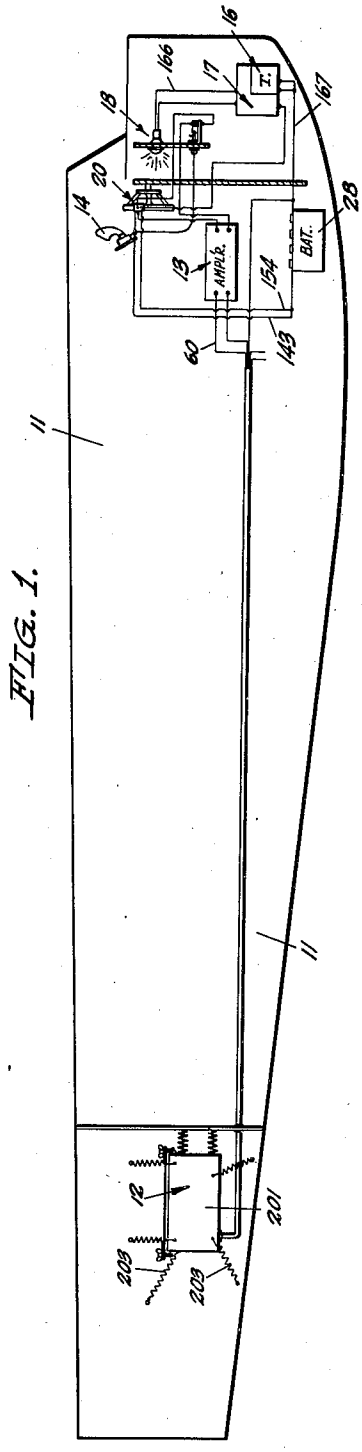


FIG. 1.

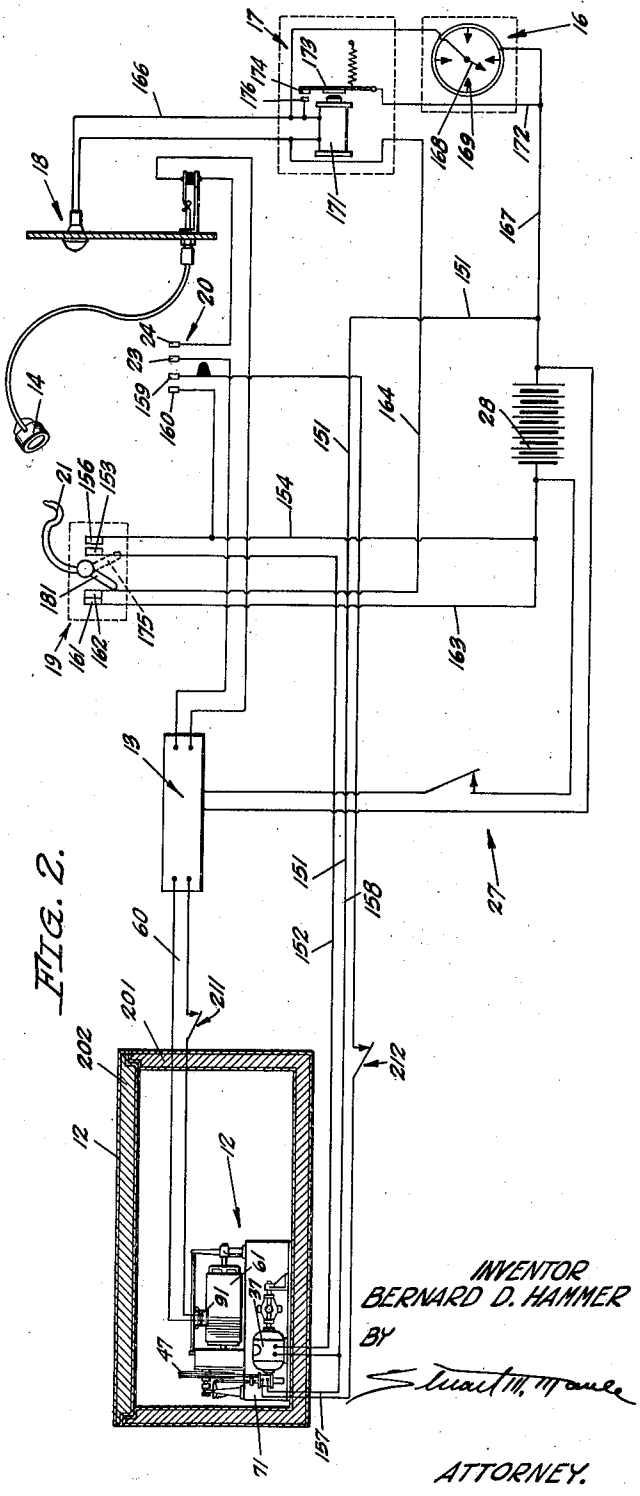


FIG. 2.

INVENTOR
BERNARD D. HAMMER
BY
Stewart III, Attorney

ATTORNEY.

Sept. 24, 1940. B. D. HAMMER 2,215,925

SOUND RECORDING

Filed March 29, 1937 4 Sheets-Sheet 2

FIG. 3.

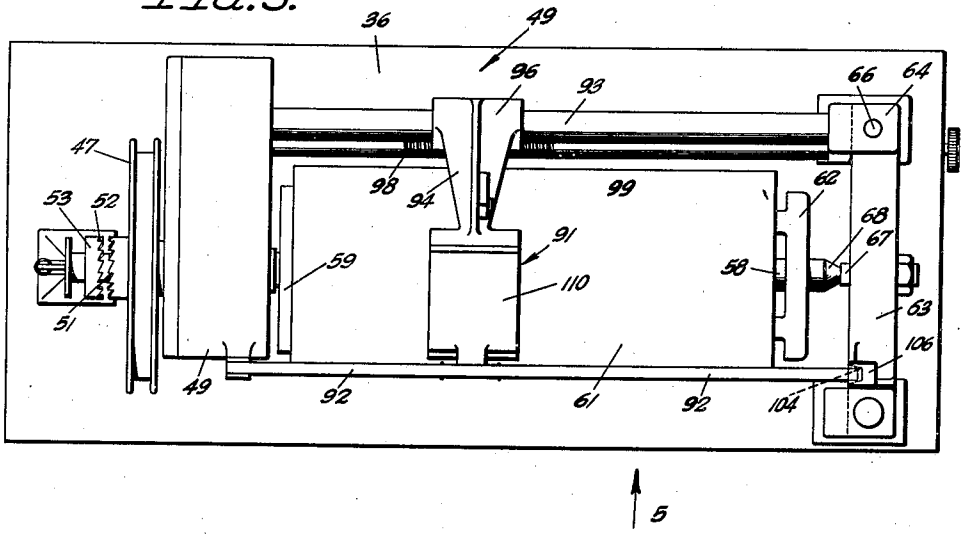
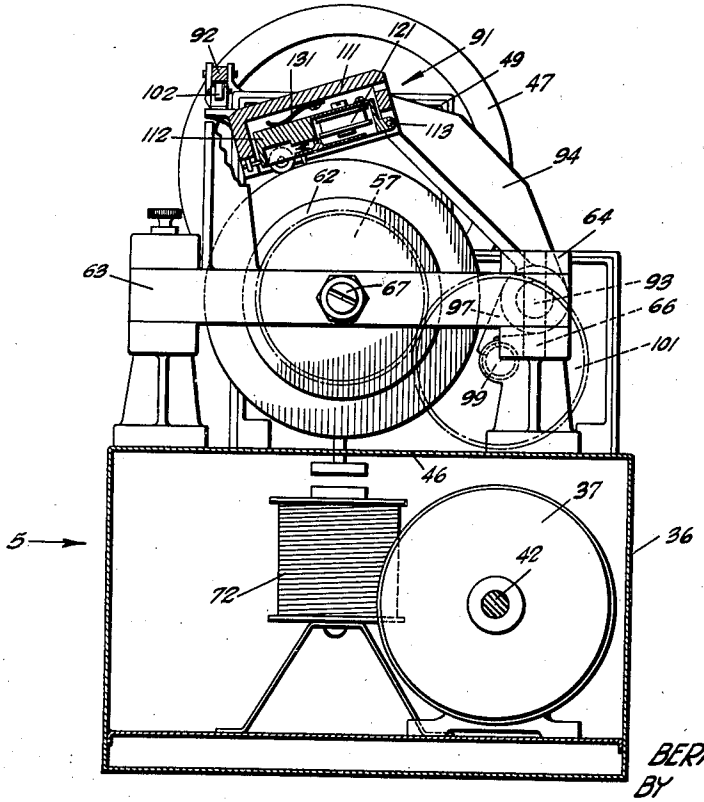


FIG. 4.



INVENTOR
BERNARD D. HAMMER
BY
Stuart M. Moule
ATTORNEY.

Sept. 24, 1940. B. D. HAMMER 2,215,925

SOUND RECORDING

Filed March 29, 1937 4 Sheets-Sheet 3

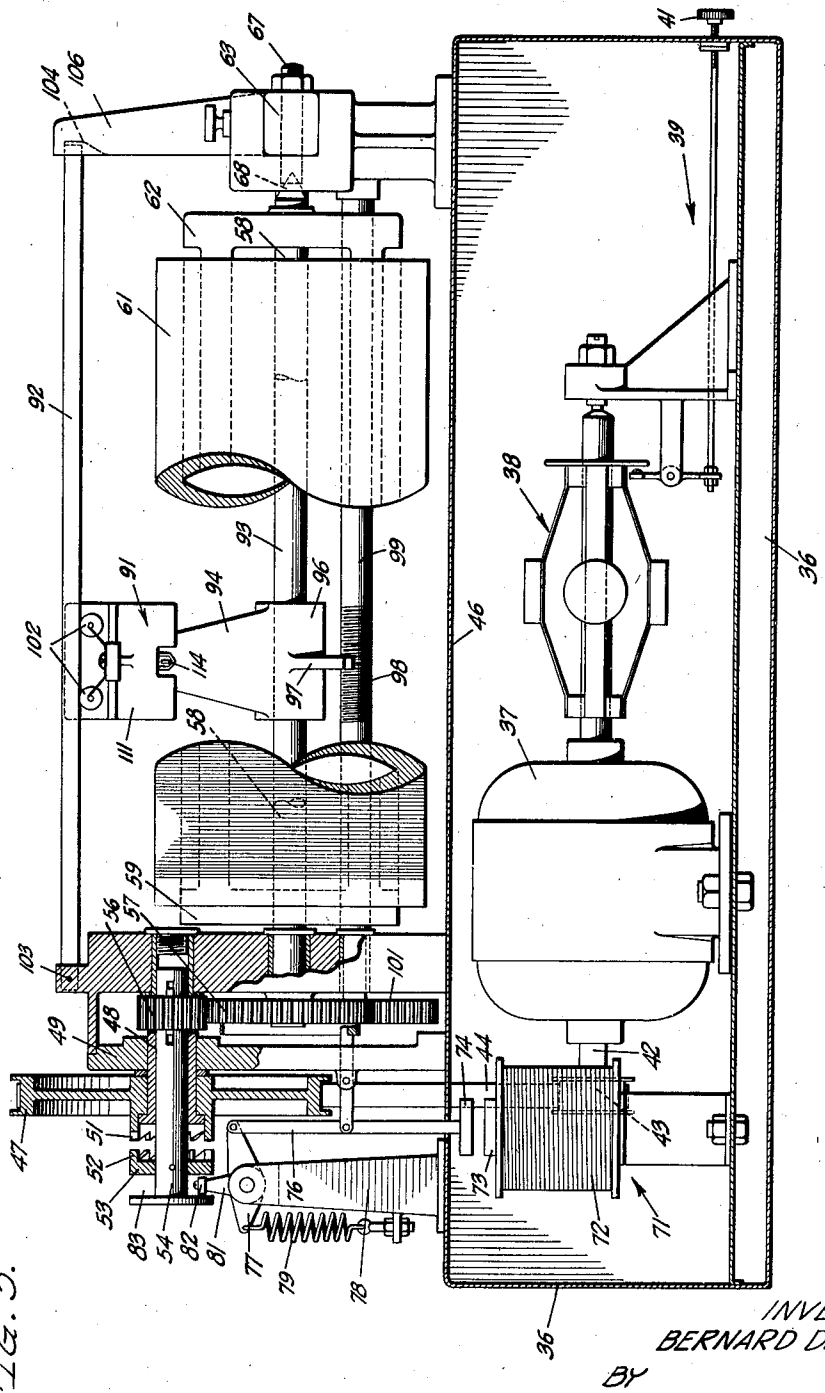


FIG. 5.

INVENTOR
BERNARD D. HAMMER
BY
Edward W. Mauer
ATTORNEY.

Sept. 24, 1940. B. D. HAMMER 2,215,925

SOUND RECORDING

Filed March 29, 1937 4 Sheets-Sheet 4

FIG. 6.

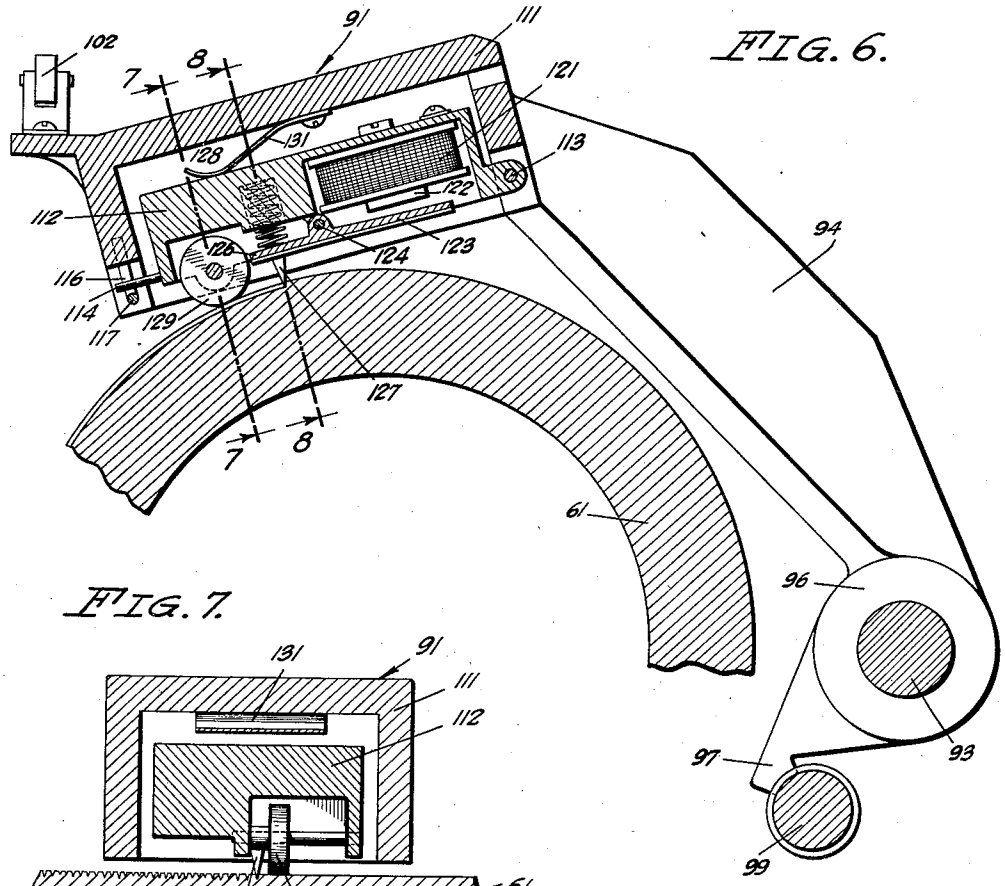
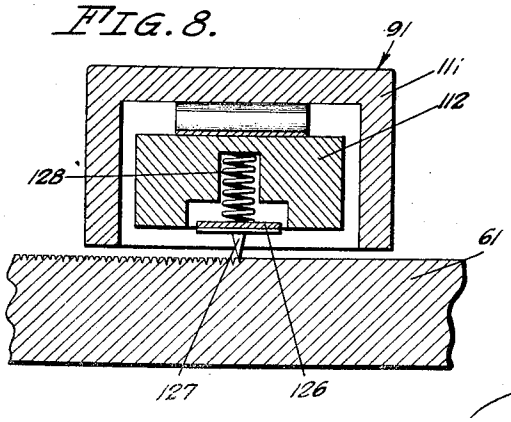


FIG. 7.

FIG. 8.



INVENTOR
BERNARD D. HAMMER
BY
ATTORNEY.

Patented Sept. 24, 1940 2,215,925

UNITED STATES PATENT OFFICE

2,215,925

SOUND RECORDING

Bernard D. Hammer, Whittier, Calif.

Application March 29, 1937, Serial No. 133,584

4 Claims. (Cl. 179—100.4)

This invention relates to sound recording, and more particularly to the use of sound recording apparatus in conjunction with radio transmitting apparatus, whereby a permanent record is made of all sounds entering the microphone of the transmitting apparatus.

An object of the present invention is to provide a sound recording apparatus co-operatively coupled with the radio transmitting set carried by a conveyance such as a ship or an airplane, whereby messages can be transmitted from the conveyance while it is in operation and simultaneously a permanent record made of such messages.

A more detailed object of this invention is to adapt the combination of recording apparatus and radio set of the general class described to use upon aircraft, and more particularly upon commercial freight and passenger carrying aircraft, in such a manner as to make it possible to produce an adequate ship's log required as a matter of ordinary routine, but without the consumption of any material amount of time and without having to do any actual writing. Whereas such a permanent record is merely a matter of routine, it is required of all commercial airline operatives and it assumes great significance whenever an accident occurs, inasmuch as the actual flying conditions encountered by the aircraft just prior to the accident may have had a distinct bearing upon the cause or causes of the accident. However, the written log is often highly unsatisfactory, inasmuch as the writing thereof requires much time on the part of the ship's officer to whom the duty is assigned, and much of his attention which had better be directed toward the safe manipulation of his craft and its passengers. Moreover, making a written log depends to large measure upon the exercise of memory by the officer, for the reason that it is physically impossible to make notations in writing of all the events, weather conditions, instrument readings and other data as fast as they occur or as fast as they are observed. Those inherent disadvantages of a written log of an airplane are more pronounced in times of stress, such as the last few seconds just preceding a serious crash, because all of the efforts of the officer are then needed more than ever for the skillful manipulation of his ship in the attempt to avoid the impending accident. Even if this were not so, the excitement of the moment under which the pilot and his assistant are laboring is apt to be so great that writing a record of the actual cause of the impending crash as then observed is wholly out of the question—and of course it is these actual causes that hold the greatest interest for all parties concerned after the crash has occurred and an investigation is being made to determine what those causes were, inasmuch as it is principally by a realization and analysis of the causes of aircraft accidents that it is made possible to make provision for the avoidance of future accidents.

Further than this, when an airliner does crash, it and its entire cargo are not infrequently consumed by fire, thus destroying the ship's log and making just that much more difficult the determination of the cause or causes of the accident.

It is apparent, therefore, that the customary type of written log of an aircraft (or any other type of conveyance for that matter) frequently fails utterly under the very circumstance where it would be most helpful were its preparation not subject to the physical limitations referred to.

It is a further object of the present invention, therefore, to provide means whereby either the pilot or one of the other members of the crew can dictate any remarks which later might prove to be of significance—in other words, by speaking into a microphone to make a permanent record of any data such as weather conditions, instrument readings, ship's position, etc. This method of preparing the log requires an absolute minimum of physical and mental effort on the part of the operator, produces the log almost instantly upon observation of the event by the operator, and detracts an absolute minimum of the operator's attention from his other duties incident with manipulation of the airplane.

Another object is to combine the record making apparatus whereby a log may be made instantly as described with the radio transmitting set with which such conveyances as ships, dirigibles and airplanes are commonly provided. It should be explained that in air transport service one of the members of the ship's crew is required to report to his ground station at regular intervals, giving the ship's position and speed, weather conditions and other data whereby an accurate check of the airplane's progress along its course can be maintained by the ground crew. These data are the principal items constituting the usual ship's log which previously has had to be written out in longhand, thus requiring duplication which by this invention is made unnecessary, inasmuch by proper manipulation of a switch the remarks to be transferred by radio to the ground station can be transmitted to and recorded by the recording apparatus.

A still further object is so to mount the recording apparatus that it is amply protected from the vibration and tilting out of true horizontal position to which the airplane is subject during flight and from the shock incident to actual crack-up of the airplane so that any record which had been made up to the time of the crash will be preserved to serve for what value it may have toward permitting investigators to determine the actual cause of the accident.

A still further object is to insulate the recording apparatus in such manner that even though the entire ship and its cargo be destroyed by fire the record still will be preserved.

Yet another object is to combine with the apparatus hereinabove described a warning signal so arranged that the pilot or other duly appointed member of the ship's crew is automatically warned at the prescribed intervals of time when he should report to his ground station, the mechanism being so arranged that the warning signal persists until the report actually is made.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of my invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood that I do not limit myself to the showing made by the said drawings and description, as I may adopt variations of the preferred form within the scope of my invention as set forth in the claims.

Referring to the drawings:

Fig. 1 is a diagrammatic view showing the outline of the fuselage of an airplane and a schematic layout of the sound recording apparatus and associated devices embodying the principles of the present invention.

Fig. 2 is an enlarged diagrammatic view showing a wiring diagram of the device of the present invention.

Fig. 3 is an enlarged top plan view of one embodiment of the sound recording apparatus which forms one of the units of the combination representing the subject matter of the present invention.

Fig. 4 is a view in end elevation, partly broken away and showing in vertical section the sound head of the sound recorder of Fig. 3.

Fig. 5 is a view in front elevation, the direction of view being indicated by the arrows 5 of Figs. 3 and 4, this view being partly broken away and shown in section.

Fig. 6 is an enlarged view in transverse vertical section taken through the sound head and a portion of the record with which it is cooperatively associated.

Fig. 7 is a transverse sectional view taken upon the line 7—7 of Fig. 6 with the direction of view as indicated.

Fig. 8 is a transverse sectional view taken upon the line 8—8 of Fig. 6 with the direction of view as indicated.

In terms of broad inclusion, the present invention contemplates the combination of a means of conveyance such as a ship or airplane, a radio transmitting set carried thereby and through the expedient of which messages may be transmitted while the conveyance is in operation, and a sound recording apparatus whereby a permanent record may be made of any or all messages transmitted by means of the radio set. Appropriate controls are provided whereby both the transmitting set and the recording apparatus may be made operable independently of each other or simultaneously as the operator may elect. Various other details of refinement will be explained in greater detail hereinbelow.

I have shown on Figs. 1 and 2 in schematic form a proposed arrangement of parts within the fuselage 11 of a conventional transport airplane which cooperate with each other to present the combination forming the subject matter of the present invention. Among these elements are a sound recording apparatus 12, a radio transmitting set, the amplifier of which is indicated at 13, a microphone 14 of suitable design, a conventional interval timer 16, an electrical relay 17 associated therewith, a warning signal 18, a control switch 19, and a dictating switch 20, all of which will be explained in greater detail hereinbelow.

Suffice it for the purpose of the present disclosure to explain that the radio set of which the amplifier 13 is indicated diagrammatically is not illustrated, inasmuch as any suitable and conventional transmitting set may be employed advantageously in connection with the present invention. Preferably it is a short wave transmitter, inasmuch as this is the type commonly employed for the type of service for which the present invention is primarily intended. In order for the pilot or other member of the crew of the airplane to cause a permanent record to be made of any comments, it is necessary only for him to lift the microphone 14 from a receiver hook 21 or other element provided to hold the microphone when it is out of use, and to close a switch disposed in convenient location, before talking into the microphone. The hook is movable, and when the weight of the microphone 14 is removed therefrom, it operates to close switch contacts which control the motor circuit of the sound recorder.

The sound recording apparatus receives its actuating energy from the battery 28. It comprises the housing 36 within which is mounted a motor 37, the speed of which can accurately be regulated by a suitable governor 38, of any suitable design and preferably provided with an adjustment mechanism 39, regulable as by a manually operable thumb screw 41. A shaft 42 of the motor 37 carries a pulley 43, engaged by a belt 44, both runs of which extend upwards through suitable apertures in the top 46 of the housing 36 to engage also a larger, driven pulley 47, which is freely revoluble upon a tubular spindle 48 carried by a frame 49 mounted upon the top 46 of the housing 36. The outer face of the hub of the driven pulley 47 carries a plurality of ratchet teeth 51 releasably engageable by complementary ratchet teeth 52 carried by a clutch plate 53 which is affixed to a shaft 54 which extends through the tubular spindle 48 and is revoluble thereinside and which is axially movable far enough to permit engagement or disengagement of the teeth 52 of the clutch plate 53 with or from, respectively, the teeth 51 of the pulley 47. Beyond the spindle 48 from the clutch plate 53 the shaft 54 carries a gear 56 which enmeshes another gear 57 which is affixed to the shaft 58 upon which a drum 59 is mounted, to be rotated thereby. This drum is of elongated cylindrical form and is adapted to receive a cylindrical record 61 of wax or other suitable material adapted to receive the impression of a vibrating needle so as to produce the sound track impression in the wax, which results from the transmission of electrical impulses to the sound head 31. It should be explained that these impulses are delivered to the sound head by a suitable circuit 69 leading from the amplifier 13, so that a record can be made of any speech or other sound entering the microphone 14 while the contacts 23 and 24 are engaged.

The end 62 of the drum 61 opposite that with which the gear 57 is associated is supported by a bracket 63 which is pivoted to the tail piece 64 of the frame 49 as by a pin 66 so as to permit a stub

shaft 67 which is carried by the arm 63 optionally to be swung into supporting contact with a conical point 68 on the shaft 58 or away from the point 68 so as to permit removal of a record 61 from the drum 62 or the replacement thereof by another record.

The shaft 54 and plate 53 of the clutch are caused to move axially through the expedient of the clutch operating mechanism 71 comprising an electro-magnet 72 adjacent the core 73 on which the armature 74 is so disposed that it is adapted to be drawn vertically downward when the electro-magnet 72 is energized. The armature 74 is connected by a lock 76 with a rocker arm 77 mounted upon a bracket 78. A spring 79 continually urges the rocker arm 77 to move in that direction which lifts the armature 74 away from the core 73 of the electro-magnet 72 and which causes the plate 52 of the clutch to move to its disengaging position, which movement is effected through the expedient of a finger 81 carried by the rocker arm 77 and having a roller 82 thereon operatively disposed within the annular groove 83 in the clutch plate 53.

Thus it may be seen that when the motor 37 is energized the shaft 42 and driven pulley 47 will be caused to revolve at constant speed, as determined by the adjustment of the thumb screw 41. Then by energization of the electromagnet 72 the clutch plate 52 is brought into engagement with the teeth 51 of the pulley 47, causing the shaft 54 to rotate, which imparts rotation to the drum 62 carrying the record 61.

A sound head, indicated in its entirety at 91, is disposed closely adjacent the face of the record 61 and is mounted for movement longitudinally with respect thereto through the expedient of upper and lower ways 92 and 93 respectively. The lower way 93 is preferably in the form of a rod of circular cross-sectional configuration. It carries an arm 94 which is movable axially in sliding movement upon the rod 93, inasmuch as the rod 93 extends through a cylindrical hub 96 formed on the lower end of the arm 94. Advance of the arm 94 along the rod 93 is effected through the expedient of a finger 97, the outer end of which carries a few segmental threads which engage the threads 98 of a feed rod 99 revolubly carried by the frame 49, a gear 101 affixed to the feed rod 99 is enmeshed with the gear 57 whereby the drum 62 is rotated. Hence when the threads of the finger 97 are engaged with the threads 98 of the feed rod 99 and the drum 62 caused to rotate, the arm and sound head 91 carried thereby will be caused to move longitudinally with respect to the drum 62 and at a speed bearing a predetermined relationship to the speed of rotation of the drum.

The upper end of the arm 94 carries small rollers 102, which are disposed in rolling engagement with the under side of the upper way 92. The parts are so positioned and arranged that upward movement of the arm 94 and roller 102 carried thereby is necessary to effect disengagement of a feed finger 97 from the feed rod 99, and of course this is prevented without movement of the upper guide way 92, inasmuch as the roller 102 engages the under side thereof. Consequently the upper gear rod 92 is pivoted at one end as by a pin 103, whereas the other end is engaged within a notch 104 in the inner face of an extension 106 of the bracket 63. Hence when the bracket 63 is swung aside to permit replacement of a record 61, the upper way 92 becomes disengaged and can be swung upwards away from the record 61.

Adjacent the upper end of the arm 94 and preferably integrally formed thereon is a housing 111 within which the sound head 91 is installed. This sound head 91 comprises a suitable cage 112 which is pivoted to the housing 111 adjacent one end thereof as by a pin 113. The other end of the cage 112 is permitted a limited degree of vertical movement within the housing 111, the extent of such movement being determined by a guide pin 114 carried by the housing 111 and extending through an eye 116 carried by the cage 112, a head 117 being provided on the outer end of the pin 116 which is engaged when the cage reaches its lower extreme of movement.

Electrically operated vibrating apparatus comprising preferably a suitable solenoid 121, core 122 and armature 123 is carried by the cage 112. The armature 123 is pivoted as at 124 and the end 126 of the armature 123 remote from the solenoid 121 carries a vibratory needle 127 which extends into record making engagement with the record cylinder 61 carried by the drum 62. A coil spring 128 under compression between the armature 123 and the cage 112 continually urges the needle 127 toward the record. Movement of the cage 112 toward the record is limited by means of a roller 129 journaled upon the outer end of the cage and disposed in rolling engagement with the outer face of the record 61. Thus it may be seen that because of the relative movement which I have made possible between the cage 112 and the housing 111, the needle 127 will always be maintained in proper relationship with respect to the record even though the housing 111 is subjected to a considerable degree of vibration or actual movement toward or away from the record. A relatively soft spring 131, preferably of the lift variety, is interposed between the cage 112 and the housing 111, to insure that the needle 127 will be maintained in proper position with respect to the record, even though the entire apparatus be inverted.

Although any suitable source of electrical energy may be employed for the energization of the motor 37 and the clutch operating mechanism 71 of the sound reproducing apparatus, they preferably derive their energization from the same source 28 as that which energizes the radio transmitting set. Hence, in the embodiment herein being described, the motor 37 has associated therewith a circuit comprising a conductor 151 leading from one terminal of the battery 28 to the motor 37, another conductor 152 leading to a contact element 153 within the control switch 19, and still another conductor 154 leading from the associated switch contact 156 back to the other terminal of the battery 28. The contacts 153 and 156 are so arranged with respect to each other and with respect to the receiver hook 21 that when the microphone 14 is lifted from the hook 21 the contacts 153 and 156 are brought together, thus effecting energization of the motor 37.

The electromagnet 72 of the clutch operating mechanism can be similarly energized through the expedient of a conductor 157 leading from the conductor 151 and hence already in electrical communication with one terminal of the battery 28. Another conductor 158 leads from the electromagnet 72 to a switch contact 159, which is disposed within the dictating switch 20. The switch contacts 23 and 24 previously described as being arranged to control the microphone circuit 26 are adapted to be brought into electrical communication with each other when preferably

manual pressure is exerted on a switch 20, which is disposed in position conveniently accessible to the operator. Preferably this switch is mounted upon the control wheel or upon the "joy stick", and in the event that multiple controls are provided, one such switch 20 is mounted upon each of such members.

Still another set of contacts 161 and 162 are disposed inside the control switch 19, these contacts, however, being in electrical communication with each other when the receiver hook is down and the other switch contacts separated from each other. The contact 161 is connected as by a conductor 163 to one terminal of the battery 28, whereas the contact 162 is connected by a conductor 164 which leads to one terminal of the light 18. The other terminal of the light 18 is connected by a conductor 166 to one terminal of the automatic timing device 16, and the other terminal of the timer 16 is connected as by a conductor 167 to the other terminal of the battery 28, with the result that the signal light 18 is energized whenever the receiver hook 21 is depressed and the constantly moving contact 168 of the timer 16 is in contact with any one of the several stationary contacts 169 of the timer 16.

The relay 17 is associated with the timer 16 and the light 18 so as to cause the light 18 to remain energized until the pilot or one of his assistants lifts the receiver hook 21, as by removing the microphone 16 therefrom, which he must do in order to make a report either to his log or to his ground station by means of the short wave radio set. The conductor 164 from the switch contact 161 also leads to one terminal of the electromagnet 171 of the relay 17. From the conductor 167 which leads to the stationary contacts 169 of the timer 16, a secondary conductor 172 is shunted around the timer 16 and leads to the armature 173, which is adapted to be moved to the left, as viewed upon Fig. 2, when the electromagnet 171 is energized. Such movement of the armature 173 brings its contact 174 into engagement with a contact 176 which is in electrical communication with the conductor 166 leading to the opposite terminal of the signal light 18 from that which is connected to the conductor 164.

A function of the relay 17 is to insure that the light 18 remains illuminated even after the moving contact 168 of the timer 16 has become disengaged from the stationary contact 169, which had last been engaged thereby, until such time as the pilot or his assistant actually lifts the microphone 14, as is required for him to make his periodic report. It will be observed that the microphone hook 21 carries an extension 181 which engages the contact 162 when the hook 21 is down, bringing the contact 162 into engagement with the contact 161. However, when the hook 21 is lifted, the contacts 161 and 162 are separated, suitable resilient means (not shown) being provided to normally hold these contacts separate, as is also shown in the case of the contacts 153 and 156, 156 and 159, and 23 and 24.

Operation

Since the timer 16 operates by clockwork (not shown) or other means for bringing the movable contact 168 thereof into engagement with one of its stationary contacts 169 at regular intervals of time, say every fifteen minutes, the warning light 18, which preferably is positioned upon the instrument board so as to command the attention of the operator of the airplane or other member of the crew, will be illuminated at regular intervals, these intervals corresponding to the periods of time at the end of which the ground station requires a report from the airplane. Normally, of course, the microphone 14 rests upon the hook 21 so that the finger 181 of the hook holds the contacts 161 and 162 in electrical communication with each other. Accordingly, when the movable contact 168 of the timer 16 next engages any one of the stationary contacts 169, current will flow from the battery through the conductor 167, the timer 16, and the conductor 166 to the light 18, thence by way of the conductor 164 to the stationary contacts 162 and 161, and thence back to the battery 28 by the conductor 163. In the event that the operator delays making his report until such time as the movable contact 168 has passed out of engagement with the fixed contact 169, the light 18 will remain illuminated, owing to the fact that when the light 18 is further energized as described, current also flows through the electromagnet 171 which is connected in parallel with the light 18. This energization of the electromagnet 171 causes the contact 174 to engage the contact 176, so that after the flow of current through the timer is interrupted it will continue to flow to the light 18 by way of the shunt conductor 172 through the contacts 174 and 176 to the conductor 166. However, immediately upon lifting the microphone 14 the contact 162 will move away from the contact 161, thus not only de-energizing the light 18 but also the electromagnet 171, permitting the contacts 174 and 176 to separate, with the result that even though the microphone again be placed upon the hook 21 shortly thereafter, the light 18 will not again be energized until the movable contact 168 of the timer 16 engages the next successive fixed contact 169.

When the hook 21 rises (it being understood that such movement is insured as soon as the microphone 14 is lifted therefrom), through the expedient of suitable resilient or other urging means (not shown), the finger 175 on the hook 21 moves the contact 153 into engagement with the contact 156. This completes the circuit which includes both the battery 28 and the motor 37 of the sound recording apparatus. Energization of the motor 37 before any of the other circuits are completed is desirable, inasmuch as it takes an appreciable period for the motor 37 to gain its true speed, and by combining this circuit of the motor slightly before completion of the circuit of the clutch actuating mechanism, it is assured that the motor will be running at full speed before the clutch 53 is engaged to cause the record 61 to revolve.

In the event that the operator desires to make a record of any comments without sending such comment over his short wave transmitting apparatus, he operates the dictating switch 20 to bring the contact 160, which is connected to the battery 28, into engagement with the contact 159, thus effecting energization of the clutch-engaging mechanism 71, and causing the cylinder of the recording apparatus to revolve. The switch 20 is so arranged that when the contacts 159 and 160 are electrically engaged, the contacts 23 and 24 of the microphone circuit also are engaged; and, as the motor 37 is already in operation as the result of the fact that the microphone has previously been lifted from its hook 21, any sounds then entering the micro-

phone will be recorded upon the record 61. As explained, the amplifier portion 13 of the short wave transmitting set remains energized while the airplane is in operation, so that no time is required for the tubes thereof to become heated; hence the apparatus is in condition for recordation almost instantly, so that there need be no loss of time for the operator to make a permanent record of any comments such as statement of the condition of the weather, instrument readings, the ship's position, or the like; or in times of excitement, such as might be expected in the short intervals just before an impending accident, the operator is given opportunity to cause to be preserved his observations as to the cause of that accident. Previously it has largely been a matter of pure conjecture as to the cause of many of the recent airplane accidents, and the lack of positive information has been a serious handicap to the adoption of regulations and new design which probably would aid materially in the avoidance of future similar accidents. Such action on the part of the operator requires no more time other than merely that required for the recitation of the words necessary to describe the actual condition and requires practically no distraction of the operator's mental or physical efforts toward avoidance of the accident.

By mounting the sound recording apparatus 12 in a fire- and heat-proof compartment 201, having a lid 202 of similar construction, and by mounting this compartment in the extreme after end of the empannage, this part of the airplane being that which is least liable to destruction in the event of a serious crash, it is believed that in most instances at least the record on the sound recording apparatus 12 will be preserved, even though the rest of the ship be substantially completely demolished. In order to protect the apparatus from the shock which is incident to such a crash, as well as from the vibration to which the entire conveyance is subjected, due to the operation of its driving engines, a compartment 201 is supported on the tail of the ship, upon a plurality of springs 203, of such a nature that they provide ample means of absorbing these shocks and vibration.

It is within the scope of the present invention to arrange the switch controls in such a manner that the transmitting set can be energized without completing the circuit whereby sound is transmitted in the form of electrical impulses to the recording head of the sound recording apparatus. This can conveniently be accomplished by opening a secondary switch 211 in the circuit 60 interconnecting the radio 13 and the sound head 91. In order that there shall be no wastage of space on the record 61, it is preferred that another switch 212 be provided in the circuit controlling energization of the clutch mechanism. If desired, these switches can all be mounted in a single housing and operated by a single control, so that by moving an indicator thereon to selected position, the operator can instantly set the apparatus to operate as desired.

I claim:

1. In a sound recording apparatus of the character described, means for supporting a record and moving it at constant speed, a guiding way thereadjacent, an arm movably mounted on said way, a housing on said arm, means for advancing said arm along said way with said housing moving across the face of said record in close proximity thereto, a sound head mounted for movement within said housing toward and away from said record and comprising a vibratory needle extending into contact with said record, a means for vibrating said needle, spring means interposed between said housing and head and urging said sound head toward said record, and a roller carried by said sound head and engaging said record to hold said head at predetermined spacing from said record, regardless of the position of said recording apparatus with respect to the horizontal.

2. In a sound recording apparatus of the character described, means for supporting a record and moving it at a constant speed, a guiding way thereadjacent, an arm movably mounted on said way, a housing on said arm, means for advancing said arm along said way with said housing moving across the face of said record in close proximity thereto, a sound head mounted for movement within said housing toward and away from said record and comprising a vibratory needle extending into contact with a record carried by said supporting means, a means for vibrating said needle, spring means interposed between said housing and head and urging said sound head toward said record, a roller carried by said sound head and engaging said record to hold said head at predetermined spacing from said record in all positions of said apparatus with respect to the horizontal, a means for mounting said sound recording apparatus upon a vehicle comprising a casing of heat-resistant and substantially shock-proof material enclosing said apparatus, and a plurality of springs between which said casing is suspended to cushion said apparatus from vibration incident to operation of said apparatus and from shock incident to disabling of said apparatus.

3. In a sound recording apparatus, means supporting a record and moving it at constant speed, an arm movably mounted thereadjacent, means for advancing said arm at a predetermined rate with respect to the speed of said record, and a sound head carried by said arm and comprising a cage, a solenoid carried by said cage, and armature pivoted on said cage and disposed in operative relation to said solenoid, a needle carried by said armature and extending into contact with said record, a spring associated with said armature and pressing said needle into contact with said record, and means carried by said armature and engaging said record to limit the distance the armature can be moved toward said record by said associated spring.

4. In a sound recording apparatus, means supporting a record and moving it at constant speed, an arm movably mounted thereadjacent, means for advancing said arm at a predetermined rate with respect to the speed of said record, and a sound head carried by said arm and comprising a cage movable with respect to said arm, spring means urging said cage toward said record, a solenoid carried by said cage, and an armature pivoted on said cage and disposed in operative relation to said solenoid, a needle carried by said armature and extending into contact with said record, a spring associated with said armature and pressing said needle into contact with said record, and means carried by said armature and engaging said record to limit the distance the armature can be moved toward said record by said associated spring.

BERNARD D. HAMMER.