May 26, 1942. J. SOUKUP ET AL 2,284,173

APPARATUS FOR RECORDING AND REPRODUCING TELEPHONE MESSAGES

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FIG. 1.

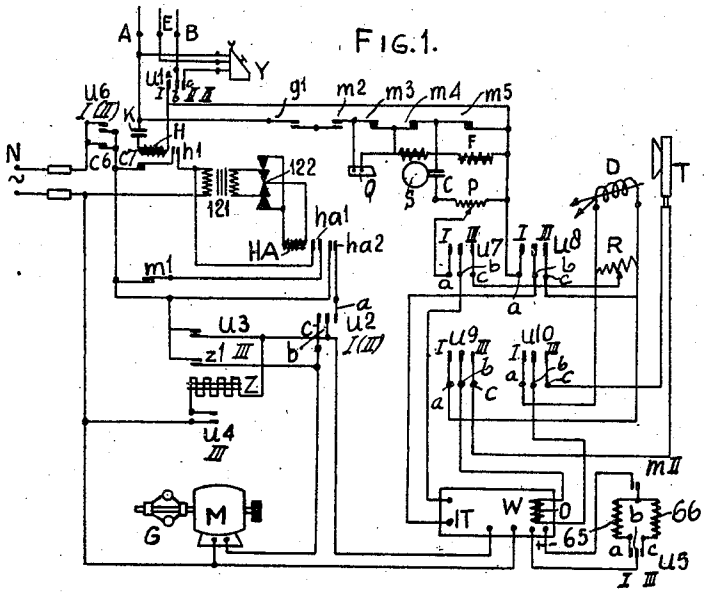
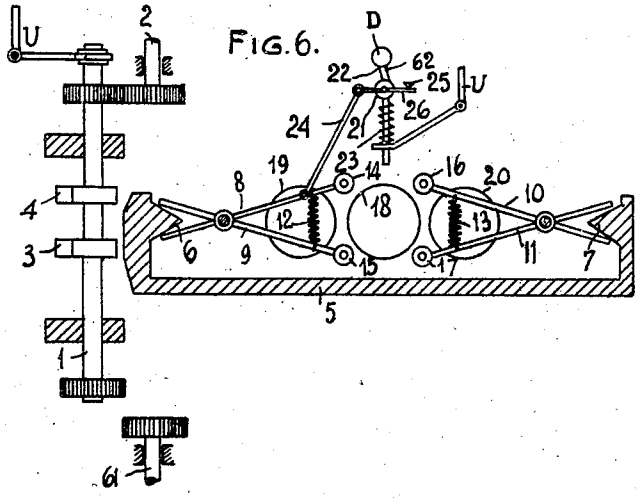


FIG. 6.



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FIG. 2.

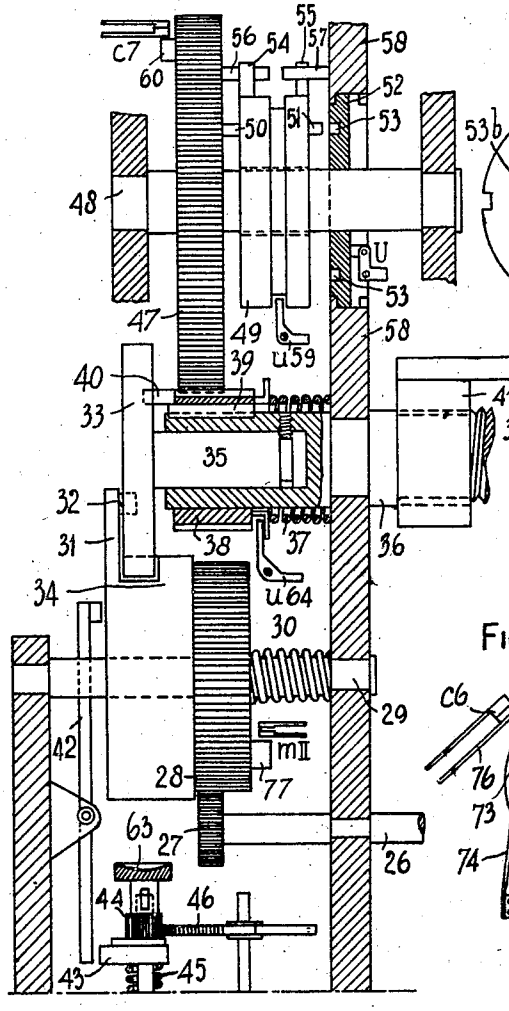


FIG. 3.

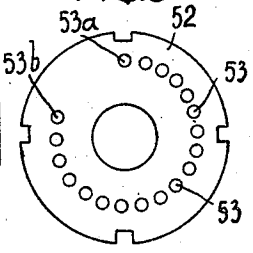


FIG. 4.

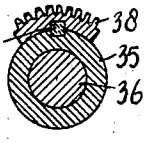
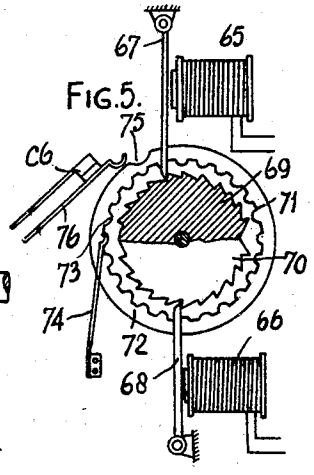


FIG. 5.



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FIG. 7.

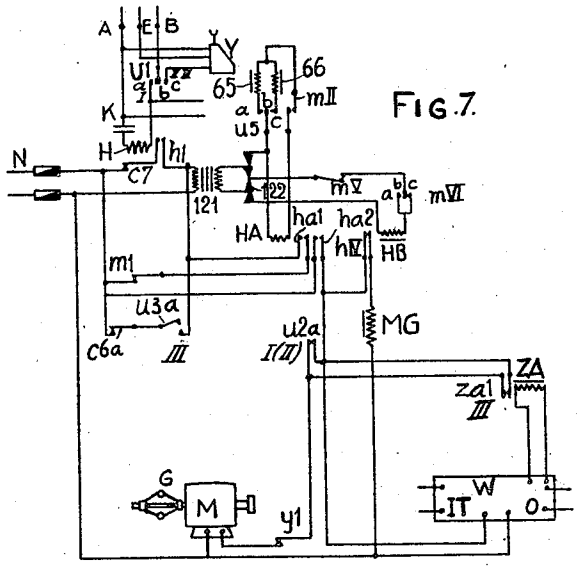
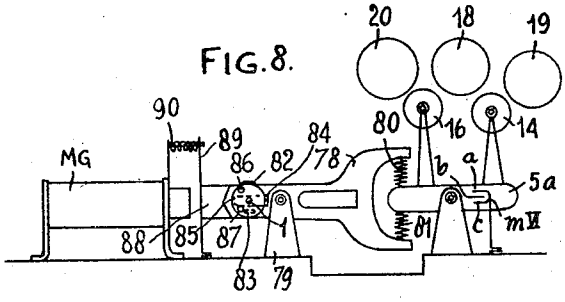


FIG. 8.



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FIG. 11.

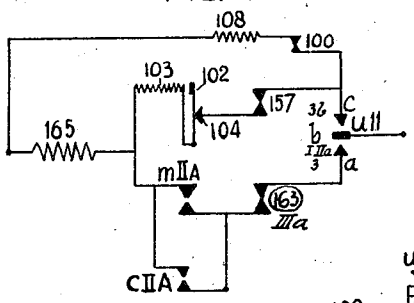


FIG. 10.

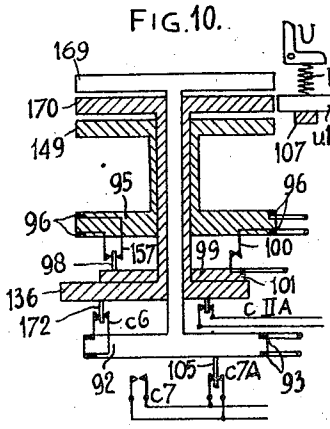
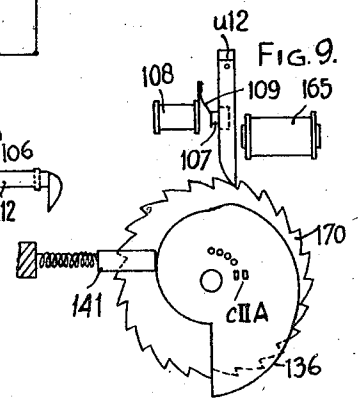


FIG. 9.



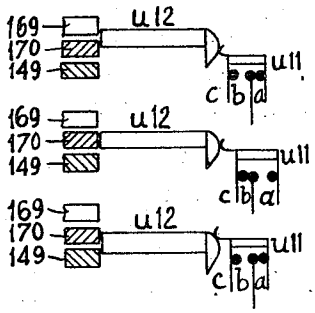


FIG. 10a. I. IIa

FIG. 10b. 36 } III

FIG. 10c. 3

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APPARATUS FOR RECORDING AND REPRODUCING TELEPHONE MESSAGES

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FIG. 12.

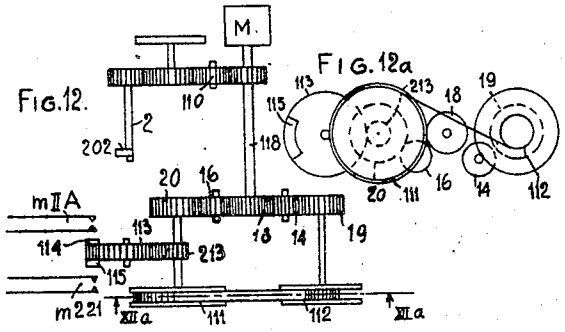


FIG. 12a

FIG. 13.

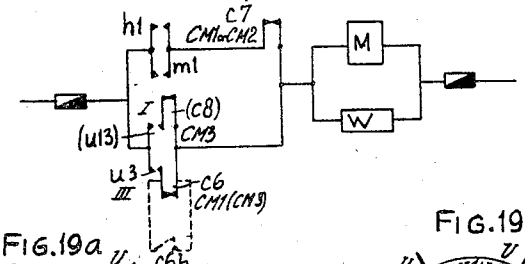


FIG. 19a

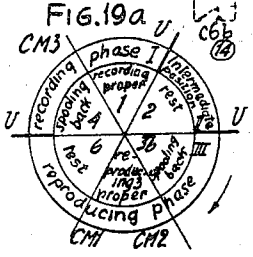


FIG. 19b.

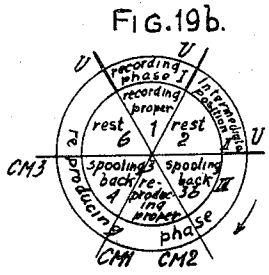
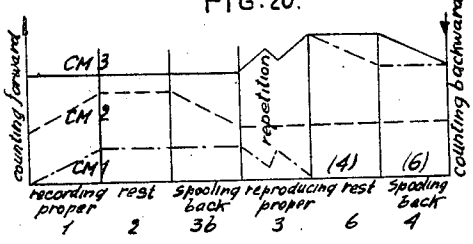


FIG. 20.



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FIG. 14.

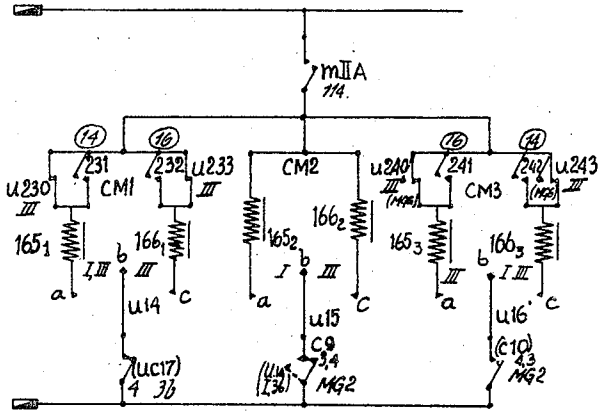


FIG. 15.

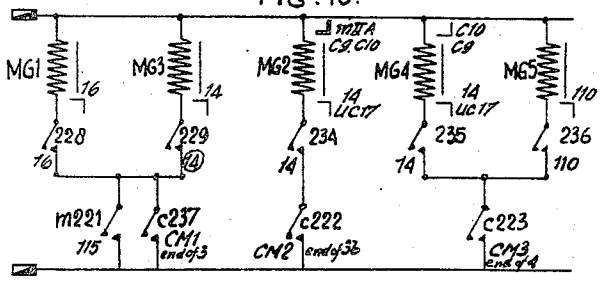
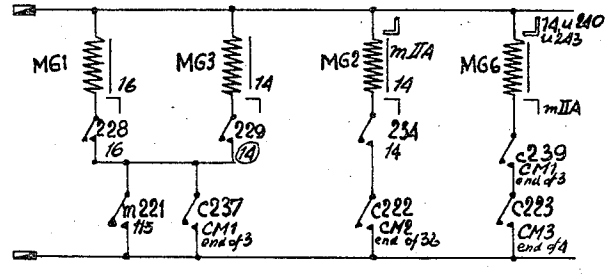


FIG. 16.



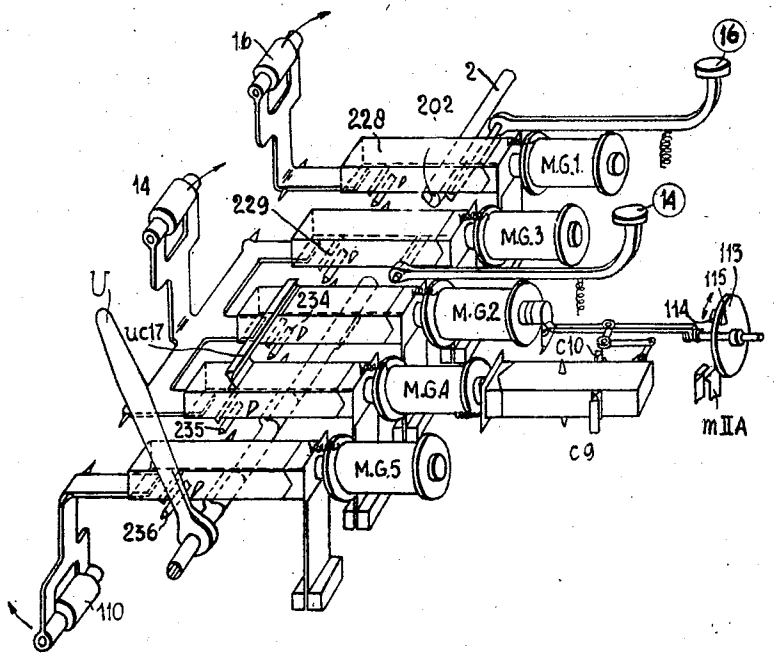
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May 26, 1942. J. SOUKUP ET AL 2,284,173

APPARATUS FOR RECORDING AND REPRODUCING TELEPHONE MESSAGES

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FIG. 15a.



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FIG 17.

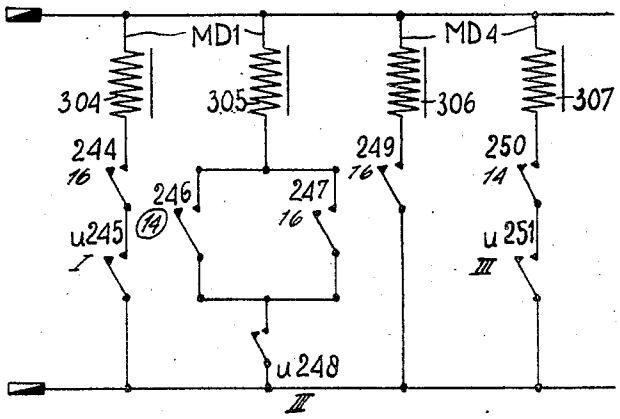
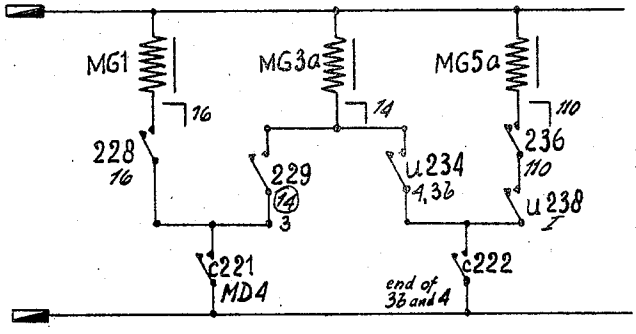


FIG. 18.



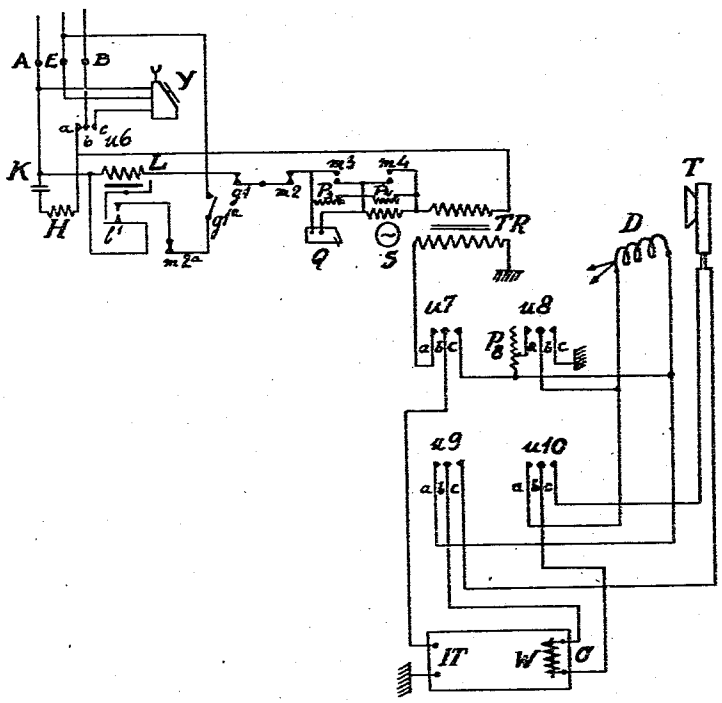
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APPARATUS FOR RECORDING AND REPRODUCING TELEPHONE MESSAGES

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FIG. 21.



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Patented May 26, 1942

2,284,173

UNITED STATES PATENT OFFICE

2,284,173

APPARATUS FOR RECORDING AND REPRODUCING TELEPHONE MESSAGES

Johann Soukup, Vienna, Germany, and Friedrich Zerner, Asniere, France

Application March 16, 1939, Serial No. 262,206
In Austria January 31, 1936

50 Claims. (Cl. 179—6)

This invention relates to sound recording and reproducing apparatus for use with telephone systems, for the purpose of recording calls incoming during the absence of the called subscriber, enabling the latter to reproduce such records at his leisure.

Means for automatically connecting apparatus of the type set forth in a telephone exchange line by the ringing current and for disconnecting the apparatus from said line after the termination of the call are well known in the art and do not form subject matter of the present invention though embodiments of such means are described for completeness.

It has already been suggested to render apparatus of the kind referred to operative for automatically recording messages by setting a single control to a "recording" position thereby causing such mechanical adjusting and electrical connection of the different elements of the apparatus that without further manual operation, for example by an incoming telephone call, the amplifier for the modulated currents to be recorded is switched in, the driving motor for the sound recording medium is started as soon as the amplifier valve cathodes have reached their emission temperature, a signal is given to the speaker informing him that the apparatus is ready for recording his message, and the motor and amplifier are switched off when the message has been terminated. The apparatus is then ready for recording the next message in a like manner as long as there is any recording medium available but the apparatus is prevented from operating on the arrival of any further messages as soon as the recording medium is used up, a counting mechanism metering the entire length of the records and either indicating this condition visually or audibly to the operator or stopping further function by disengaging the mechchanical couplings and/or electrical connections therefor.

By setting said single control to a "rest" position the apparatus is switched off and the ordinary telephone substation is connected in the usual manner to the exchange lines.

For reproduction of the recorded messages, however, it is necessary to set the control manually to a "rewinding" position in which the motor only is switched in for repositioning the recording medium to its initial position, and then to set the control to a "reproducing" position whereby the amplifier and the motor are both switched in and reproduction of all of the recorded calls from the beginning to the end is effected, unless the apparatus is stopped manually at an intermediate point.

A counting mechanism actuated by the incoming messages visually indicates the number of the messages which have been recorded and facilitates manual adjustment of the recording medium to a point wherefrom repetition may be started.

After termination of the reproduction the operator has again to set the manual control to the "rewinding" position in order to prepare the apparatus for further recording.

Due to the counting mechanism which meters the entire length of the recording medium during recording, and meters in the reverse direction during rewinding, the recording medium is automatically stopped by disengaging and/or switching off the driving motor as soon as it has been repositioned to its initial position.

Thereafter, by again setting the control to the "recording" position, the apparatus is prepared for new incoming messages.

Before recording new records on the medium, the old ones thereon have to be effaced and this is effected by the use of a strong magnetic field which polarises a steel wire serving as a recording medium, before it passes the recording electro-magnets energised by the speech modulated current.

Though the known apparatus automatically records the incoming messages and already utilises the heating period of the amplifier valve cathodes for communicating a message prepared by the called subscribed for the calling one, it is evident that they do not operate entirely automatically for reproduction but require manual readjusting and consequently a greater amount of personal attention and skill than can be obtained from the average user.

It is an object of the present invention to simplify the operation of apparatus of the kind referred to and to render such apparatus entirely automatic, reducing manual operation only to the setting of a control handle to "recording," "reproducing" or "neutral" positions, and electrical connections and mechanical adjustment, particularly repositioning of the recording medium and/or of the recording and pick-up means, being effected automatically by the apparatus itself.

In accordance with one aspect of the invention, apparatus is provided for recording telephone messages in a subscriber's absence and for subsequently reproducing such messages, which apparatus is controlled by a single control handle

having a plurality of operating positions, in one of which the apparatus is connected to a telephone line and prepared for recording incoming messages, in another of which the apparatus is disconnected from the telephone line and a telephone instrument is connected to said line, and in another of which recorded messages are produced while the apparatus is disconnected from the telephone line, the operation of said apparatus being divided into periods during which actual recording and actual reproducing take place, periods during which preparation for recording and preparation for reproducing are effected and periods of rest, said periods being grouped together into three adjacent phases, a recording phase, an intermediate phase and a reproducing phase, in such a manner that the control handle when set to any of its positions terminates one phase and simultaneously initiates an adjacent phase, a metering device being provided which limits the operation of the apparatus during recording and reproduction, and during preparation therefor to steps of predetermined length, counting mechanisms being provided which count the number of messages recorded, reproduced and repositioned during preparation for recording and reproducing and serve on reaching predetermined settings to change the mechanical and electrical connections of the apparatus, thereby automatically terminating periods other than the last one of a phase or initiating periods other than the first one of a phase.

In accordance with another aspect, the invention comprises apparatus for recording telephone messages in a subscriber's absence and for subsequently reproducing such messages, which apparatus is controlled by a single control handle having a plurality of operating positions, in one of which the apparatus is connected to a telephone line and prepared for recording incoming messages, in another of which the apparatus is disconnected from the telephone line, and a telephone instrument is connected to said line, and in another of which recorded messages are reproduced while the apparatus is disconnected from the telephone line, the operation of said apparatus being divided into periods during which actual recording and actual reproducing take place, periods during which preparation for recording and preparation for reproducing are effected and periods of rest, said periods being grouped together into three adjacent phases, a recording phase, an intermediate phase and a reproducing phase, in such a manner that the control handle when set to any of its positions terminates one phase and simultaneously initiates an adjacent phase, metering devices being provided one of which meters the length of the individual messages recorded, reproduced and repositioned during preparation for repetition, and the other of which cumulatively meters the length of the messages recorded, reproduced and repositioned during preparation for repetition, and serves on reaching a predetermined setting to change the mechanical and electrical connections of the apparatus, thereby automatically terminating the period of actual reproducing, and a switch being provided which is normally held open by the recording medium itself and is closed thereby at the ends of the periods of preparation for recording and preparation for reproducing so as to terminate said periods.

According to yet another aspect, the invention comprises sound recording and reproducing apparatus whereby telephone messages may be recorded in a subscriber's absence for subsequent reproduction, in which a single control handle is provided for connecting the apparatus to a telephone line, and for effecting all the necessary mechanical and electrical changes whereby the device or devices for recording reproducing, and the record carrier are automatically brought into their correct relative positions for recording, and for reproducing from the earliest recorded message not previously reproduced.

Counting or metering devices have been proposed in apparatus of the type set forth, for indicating visually or audibly the number of the messages recorded or reproduced. Also such counting or metering devices have been proposed for switching off the apparatus automatically whilst the recording medium was being fully wound to or fro. One object of the present invention is to control all of the functions of the apparatus automatically so that the periods above referred to are governed as to their beginning and termination by counting mechanisms when they are not initiated or terminated by manual operations of the general control handle to one of its positions or, as is known per se, by an incoming call.

The length of some periods, for example periods of actual recording or reproducing, is metered by the counting or metering devices, and the length of other periods such as rewinding of the recording medium preparatory to reproducing, or preparatory to another recording is metered back equal amounts so that the recording or reproducing devices are correctly located.

This metering is facilitated if a uniform length of records is used. Experiments have proved that a period of approximately 15 to 25 seconds is sufficient for a telephone message to be recorded, provided the calling subscriber has been informed beforehand by a message communicated to him by the apparatus that his call will be recorded, and an appropriate time has been allotted to him to determine what he is going to say.

Such a limitation of time has the advantage that the calling subscriber is forced to limit his message to essential points and avoid unnecessary vervosity, thereby economising in the recording medium. The improved apparatus is consequently most suitable for use in connection with ordinary subscriber's stations.

There are, however, applications of the apparatus according to this invention in which automatic recording and reproduction of messages is desirable, the length of which messages is not uniformly prescribed and is limited only by the capacity of the recording medium. This applies for example to telecommunicating systems in use in offices and services, such as fire brigades and the like, where trained callers are accustomed to express themseves briefly without wasting the recording medium.

Sound record carriers of any shape such as cylinders, discs, tapes or wires may be used and recording methods of any kind, such as mechanical engraving, magnetising or optical methods may be employed, though methods which do not involve subsequent developing are preferred. In some methods of recording, such as that using the well known magnetisable steel wire or tape, the recording medium may be regenerated within the apparatus itself after reproduction to enable further recording. Other methods require the recording medium to be replaced when its capacity has been exhausted,

and in such cases the records may be stored for future reference.

In the case of a recording medium not capable of being regenerated within the apparatus, it is particularly desirable to be able to continue recording on a medium on which a series of messages has already been recorded during previous occasions, in order to use up the entire capacity of the medium before exchanging it. Heretofore in known apparatus of this type, it has been necessary to start reproduction either from the commencement of the first record even if the first series had already been reproduced on a previous occasion or to adjust the apparatus manually to the commencement of the later recordings.

In preferred embodiments of this invention, repetition of any individual record may be obtained at the end of the reproduction of that record, by simply operating a repetition button or key without necessitating any manual adjustment of the recording medium or of the reproducing device to the commencement of the record to be repeated.

In certain embodiments of apparatus according to the present invention, all the messages which have been recorded on the recording medium are reproduced serially, suitable intervals being provided between the reproduction of the individual messages to enable the operator to note the contents of the messages and also to decide whether he wishes repetition of the message immediately preceding the interval. For example, when a tape is used for the recording medium, the length of which tape corresponds substantially to the length of the individual records thereon in parallel tracks side by side, such intervals are provided by the time necessary for rewinding said tape between each two successive reproductions.

In apparatus in which the records are recorded in alignment, reproduction of the individual records would be effected continuously without intervals unless an uneconomical length of unused recording medium is provided between successive records (as is done with certain known systems). In order to avoid such waste of recording medium, in apparatus of this type according to the invention, the movement of the recording medium is stopped after the reproduction of each message, and the reproduction of the next message is obtained by operation of a suitable button or key. To repeat reproduction of a message, a suitable key is depressed at the end of the reproduction of that message. This however is considerably simpler than the manual adjusting of the apparatus which has been necessary hitherto.

The general ideas of the invention as briefly outlined hereabove and many inventive details enabling automatic functioning of the apparatus will be more readily understood from the following description of some embodiments, shown diagrammatically and only by way of example, of the invention as illustrated in the drawings affixed to this specification and forming part thereof. The invention is, however, not limited to these embodiments, and details described in connection with one embodiment may be readily exchanged for details of other ones.

Figs. 1–12*a* of the drawings relate to embodiments of the invention in which is used a recording medium not capable of regeneration and on which the individual messages are recorded side by side in parallel tracks, while Figs. 13–20 relate to embodiments of the invention, in which a recording medium is used which is capable of being regenerated within the apparatus.

In the drawings

Fig. 1 is a circuit diagram representing circuits of the apparatus connected to public supply means, the circuits derived therefrom and the circuits connected to the exchange office.

Fig. 2 is a side elevation, partly in section, of a device for automatically repositioning the recording and pick-up device to the commencement of the first record which has not yet been reproduced or alternatively to the commencement of the unused space on the recording medium.

Figs. 3 and 4 are details of the device shown in Fig. 2, in front elevation and in cross-section respectively.

Fig. 5 is a side elevation of a device for automatically switching off the sound recording and reproducing device.

Fig. 6 is a diagrammatic view of a mechanism for coupling reels of tape serving as a recording medium, with a driving motor for rotating the reels in either direction.

Fig. 7 is a circuit diagram similar to Fig. 1, but modified somewhat and representing only the circuits connected to and derived from the public supply mains.

Fig. 8 is a diagrammatic view of mechanism for coupling reels of recording medium with a motor to rotate the reels in either direction.

Figs. 9 and 10 are a front elevation and a section, respectively, of a device for automatically repositioning the recording and reproducing pick-up means to the commencement of the first record not yet reproduced, and also for automatically switching off the apparatus, which device may also be applied to an arrangement using two tapes serving alternately as recording medium.

Figs. 10*a*, 10*b* and 10*c* show details of the arrangement shown in Fig. 10, representing different positions of the mechanism.

Fig. 11 is a circuit diagram of the mechanism shown in Figs. 9 and 10.

Fig. 12 is a diagrammatic view of an apparatus for recording messages in alignment.

Fig. 12*a* is a sectional view on the line XI—XI in Fig. 11.

Fig. 13 shows diagrammatically a motor and an amplifier circuit diagram for the apparatus shown in Fig. 11.

Fig. 14 is a circuit diagram of a metering device for the apparatus.

Fig. 15 is a circuit diagram of controlling electromagnets for the apparatus.

Fig. 15*a* is a diagrammatic view of the mechanical arrangement of these electromagnets.

Fig. 16 is a modification of the circuit diagram shown in Fig. 14.

Fig. 17 is a circuit diagram of a metering device of an embodiment of the apparatus for recording messages which are not of predetermined maximum length.

Fig. 18 is a circuit diagram of controlling electromagnets for this embodiment.

Figs. 19*a* and 19*b* are diagrams showing the different working periods (1, 2, 3, 3*b*, 4 and 6) of the apparatus and the manner in which they can be combined alternatively to three functional phases I, II, and III.

Fig. 20 is a diagram corresponding to Figs. 19*a* and 19*b* showing how the counting mechanisms work during the different periods.

Fig. 21 is a modified circuit diagram of the exchange line circuit and reproduction circuit.

Referring to the drawings, the reference letter *u* before a reference numeral denotes that the element enumerated is controlled by the general control handle U.

When a switch is operated by a motor-driven element such as a cam, a control shaft or the recording medium, the letter *m* is placed before the reference numeral, such as *m*2.

All the relays are denoted by the letter H and another index. When a switch is operated by a relay the letter *h* is placed before its reference numeral, such as *h*2.

Switches operated by the centrifugal governor G are denoted for example *g*2. Switches operated by counting mechanisms are denoted, for example *c*1.

Switches operated by a thermal switch Z are denoted, for example *z*2.

Switches operated by the receiver hook of the telephone instrument Y are denoted, for example, *y*2.

Switches and other parts of the apparatus operated through the agency of a key are denoted, for example, 14.

When an element is operated by another element or acts on another element the reference numeral of such other element is written in italics underneath or beside the element.

Where a switch admits different connections its contacts are denoted *a*, *b*, *c* and in the following description for example *u*2*ab* denotes that switch *u*2 is set to a position where contacts *a* and *b* contact one another while contact *c* of this switch is disconnected. *u*2*abc* signified that all three contacts *a*, *b* and *c* of switch *u*2 simultaneously contact one another.

Switches admitting only a closed and an open position are shown in their normal positions and oblique numerals placed below their reference numerals indicate the period during which the switches are moved to their other positions. When a numeral is bracketed, it indicates that the switch appertaining thereto might be closed or open during that period.

The exchange lines are denoted by A, B while E is the earth wire.

Referring to Fig. 1 of the drawings, the exchange lines AB are connected by means of a switch *u*1 either to the ordinary subscriber's station Y when set by the general control handle U to *bc* or to the sound recording apparatus when set by the handle to *ab*. When set to *ab*, an alternating current as used for a ringing signal arriving from the exchange lines AB, energises a relay H whereby switch *h*1 is temporarily closed allowing a current to pass from the public supply mains N to the primary coil of a transformer 121, switches *c*6 and *c*7 being normally closed. (Switch *u*6 is also closed by the general control handle U when set to "recording" position (I).) The secondary coil of the transformer 121 is connected to a rectifier 122, preferably a dry rectifier, the direct current circuit of which includes the coil of a relay HA, switch *ha*1 and *ha*2 which are operated thereby being open before the arrival of the ringing signal. As switch *ha*1 shunts switch *h*1, the circuit from the public supply mains N of the primary coil of transformer 121 is maintained even when switch *h*1 is opened again after termination of the ringing current, as long as a switch *m*1 is in its normally closed position.

Switch *u*2 is set by the general control handle U to *abc* for "recording" so that both the motor M and the amplifier W are thereby connected to the public supply mains N. After a predetermined number of revolutions of the motor M corresponding to the time for heating up the cathodes of the amplifier W, and for recording the incoming call, switch *m*1 is temporarily opened by a cam driven by said motor, whereby the circuit of primary transformer coil 121 is opened, relay HA de-energised, and switches *ha*1 and *ha*2 opened. The apparatus is then switched off and prepared to react on the next incoming ringing signal.

The arrangement as above described ensures a safe and silent contact and also ensures switching-in of the apparatus even in parts of the exchange network where the alternating ringing current is very weak. It can be simplified when sufficient strength of ringing current is available in all parts of the exchange network and, on the other hand when the current supplied by the public supply mains is a direct current. Alternatively, it may be replaced by another calling relay arrangement.

The relay H is connected directly to the exchange lines AB through the condenser K. When contact *b* of the switch u^1 engages contact *a*, a number of switches G1, *m*2, *m*3, *m*4, *m*5 arranged in series, are connected in parallel with the relay H across the exchange lines AB. Normally, switches G1 and G2 are open and switches *m*3, *m*4 and *m*5 are closed. These switches ensure the reliability of the apparatus as a whole in a simple manner. Thus, switch G1 is closed only when the motor M maintains a regular speed, by a centrifugal governor or the like G, arranged on the shaft of the motor or on a shaft coupled thereto. Instead of a centrifugal governor, any other control means, the action of which depends on speed (for example a fan, Frony brake, dynamo with relay or the like) may serve for the same purpose of switching off the exchange circuit as soon as the motor ceases to function in the normal manner.

The switch *m*2 is closed when the motor M has made a predetermined number of revolutions, depending upon the number of ringing signals which are to be given before the device is switched in. The closure of switch *m*2 is effected, for example, by means of a cam driven by the motor and preferably arranged on the control shaft of the sound recording and reproducing device. The direct current circuit of the exchange lines AB is thus closed and the alternating current circuit of the ringing signal is cut out.

The switches *m*3, *m*4 and *m*5 serve to maintain the direct current circuit of the exchange lines AB when once established, even when a number of auxiliary devices of the system are alternately connected to and disconnected from the circuit one after another. For this purpose these contacts are connected to the exchange line circuit in series in such manner as to shunt the said auxiliary devices and the device for recording and reproducing incoming messages. Since the resistance of these shunts is practically negligible in comparison with that of the auxiliary devices bridged over thereby, when the switches are closed, the direct current from the exchange lines will flow through these switches only, and will not be influenced by the actions of the auxiliary devices which are shunted for the time being.

After a definite further number of revolutions

of the motor M, switch *m3* is first opened by means for example, of a cam mounted on a shaft rotated by the motor, and in consequence, the direct current from the exchange lines is led through a pick-up Q which is connected in parallel with the switch *m3* and is the pick-up of a device for communicating messages prepared for the calling subscriber by the called subscriber (not to be confused with the pick-up of a sound recording and reproducing device D for recording messages from the calling subscriber which will be referred to later).

As soon as the pick-up Q has communicated the message prepared for the calling subscriber, switch *m3* is again closed and switch *m4* is opened after further rotation of the motor shaft. An electric siren S or like instrument for the generation of an alternating current of sound frequency now sends a signal to the calling subscriber. The end of this signal indicates the readiness of the device for recording, which may take place when switch *m4* is closed and switch *m5* opened after further rotation of the motor shaft. In a like manner also the state of preparation of the apparatus for recording and the end thereof may be indicated by other signals, the meaning of which may conveniently be explained in the message communicated to the calling subscriber by means of the pick-up Q.

The time between the switching-in of the amplifier W to the closing again of the switch *m4* shunting the siren S is longer than the time required to heat up the valves of the amplifier.

Instead of using a siren, a microphone which transfers acoustic signals to the exchange line AB may be shunted across the switch *m4*. Alternatively, another pick-up Q may be arranged as or in addition to the siren S in parallel with the switch *m4*, or with another switch which is controlled according to the number of revolutions of the motor M, which pick-up Q transmits a recorded message to the Exchange Office line AB from a sound record prepared by the called subscriber.

The duration of the signal emitted by the siren or the like is determined by the time which must be allowed for the calling subscriber to decide upon the message he wishes to record for the absent called subscriber. This period also enables the amplifier valves to be heated up.

The switch *m4* which is shunted across the siren S, may be opened temporarily during or just before the recording period in order to indicate portions of that period, or the approaching beginning or end thereof.

Instead of using an electric siren having a toothed wheel, the blades of a fan or an exhausting machine for removing shavings of the record carrier produced by cutting the sound record of the message may be employed. If the speed of the exhausting machine is too high for practical purposes, some of its blades may be made from a non-magnetisable material and others from a temporarily magnetisable one.

The magnet of the siren may be an electromagnet which is energised by direct current from the exchange line. In this case a contact may be disposed immediately adjacent to each of the terminals of the electromagnet, which contacts are closed just before the switch *m4* is opened, and opened immediately after this switch is closed again. The capacity of these contacts should be as small as possible in order to render their resistance to alternating currents so high that any influence of the siren on the amplifier is prevented.

By setting the control handle into the position for recording, as for example on the subscriber leaving his instrument, the contacts *b* of switches *u7*, *u8*, *u9*, and *u10* are brought into engagement with the contacts *a*. Consequently, the direct current from the exchange line wire A, which is modulated by the speech of the calling subscriber passes via switch *m4* through switch *u7* to the input transformer IT of the amplifier W and therefrom through switch *u8* back to the exchange line wire B.

Instead of being applied through an input transformer IT to the amplifier W, a modulated alternating current may be applied directly to the grid of the amplifier input valve, after being diverted from the exchange line direct current circuit by means of an alternating current shunt. This result will be obtained if, for example, the direct current circuit is closed, when the switch *m5* is opened, through a choke F, the alternating current resistance of which is so high that the modulated alternating current of sound frequency cannot pass therethrough, whereas its resistance to direct current is suited to the wiring of the telephone system. A condenser C, on the other hand, cuts off the direct current circuit from the amplifier.

The contact *b* of the switch *u7* is now connected to the grid of the amplifier input valve, and the contact *b* of the switch *u8* is connected to the negative line of the amplifier. The potentiometer P enables the necessary grid potential to be obtained, and also permits adjustment of the amplifier so that the end stage thereof is protected against overloading. This adjustment must be made when the device is installed since the terminal energy of the alternating speech currents will be considerably different at different points of the telephone system, even with uniform energising sound energy.

But even at the same point of the telephone network the modulated alternating currents of sound frequency will be of different intensity depending on the quality of the microphone, on the loudness of the voice of the calling subscriber, and on the condition of the exchange lines at the time. The potentiometer P must, in practice, be adjusted to an average value and the differences of sound volume when recording must be compensated upon reproduction as far as possible by means of a sound volume regulator R (potentiometer).

When the differences in the intensity of the received alternating speech currents are very high, the amplifier may be equipped with automatic sound volume regulation (contrast compensation), as is well known in the telephone and radio art.

The conduction of the alternating speech currents to the grid of the input amplifier in the manner indicated above has many advantages over coupling by means of a transformer.

The amplified modulated alternating currents of sound frequency pass from the amplifier outlet O by switch *u9* to an electromagnetic recording and reproducing device D and therefrom by switch *u10* back to the amplifier output. The device D is adapted for recording the sound on a record carrier.

When the recording period is over, the control shaft rotated by the motor thereof has been turned sufficiently for the switch *m2* in the exchange line circuit to be opened by cams or the

like arranged thereon, in addition to the opening of a switch in the public supply mains circuit, whereby the system is prepared to receive new calls.

When the called subscriber returns after an absence, he first sets the control handle into an intermediate position whereby the contact *b* of the switch *u1* engages with the contact *c*. However, the switches in the public supply mains circuit for initiating the reproducing operation of the apparatus are not yet closed. At this moment the switches *u7*, *u8*, *u9* and *u10* may or may not be closed in the position for reproduction (i. e. the contacts *b* and *c* thereof engaged), but if not closed in this position they may be so closed by setting the control handle into its position for reproduction.

If now the called subscriber wishes to have any records reproduced, he sets the control handle into its position for reproduction, whereby the contacts *b* of the switches *u7*, *u8*, *u9* and *u10* are connected to contacts *c* thereof if this has not already been done in the intermediate position.

The recording and reproducing device D is adjusted by the control handle to its picking-up position and then sends weak sound frequency alternating currents through switch *u7* to the amplifier inlet IT and thence through switch *u8* back to the recording and reproducing device D. A regulator, such as a potentiometer R, connected in parallel with the device D, permits regulation of the sound volume. From the amplifier output O, the amplified modulated alternating currents of sound frequency pass via switch *u9* to a telephone receiver or loudspeaker T, and thence through switch *u10* back to the amplifier output.

By suitably constructing the recording and reproducing device D, it is possible to hear the modulated alternating currents produced thereby with a telephone receiver and without amplification. In this case the switches *u7*, *u8*, *u9* and *u10* are modified accordingly. Thus, for example, the contact *c* is omitted from the switches *u7* and *u8*. The contacts *b* of these switches are then closed by connection with contacts *a* for recording, and opened for reproduction. In the case of the switches *u9* and *u10*, the contact *a* is in each case disposed as the middle one and the contact *b* as the left one, i. e. the two contacts are interchanged with one another.

The arrangement as shown in Fig. 1 may be somewhat modified as shown by Fig. 21.

In this modified arrangement, a relay L is arranged in the line leading from the exchange line A to the switches G1, *m2*, *m3*, *m4* and *m5*, connected in series with respect to one another. (Switch *m5* may be dispensed with as will be explained hereinafter.) When switch G1 has been closed by the centrifugal governor G (Fig. 1) and switch *m2* by a cam or the like, the relay L is energised by the direct current coming from the exchange line. The armature of relay L then opens a switch l^1 and thereby prevents the exchange lines from being connected, through a switch *m2a*, to the earth wire E.

The switch *m2a* is closed and opened concurrently with switch *m2* by means of a cam driven by the operating motor M (Fig. 1) for the general device.

Now when the calling subscriber does not wish to communicate any message to the called subscriber and accordingly interrupts his connection with the latter, the relay L drops its armature and switch l^1 is closed, so that one of the wires to the exchange is connected to the earth wire E as long as the cam rotated by the motor keeps the switch *m2a* closed, which is during the entire recording period after a predetermined number of revolutions of the motor.

The called subscriber's station thus gives the "engaged" signal to any further subscriber calling during this period. When the entire cycle of the recording period is over, switch *m2a* is again opened by its operating cam and the apparatus is ready to receive new calls.

In order that the "engaged" signal shall be given only when the recording and reproducing apparatus is actually operating, the circuit connecting one of the exchange wires to the earth line E is maintained open until the motor M has reached its normal operating speed, and is opened again if the speed of the motor falls below the normal value. For this purpose, a further switch g^2, controlled for example by the governor G so that it remains closed as long as the motor M maintains its normal speed, may be included in series with the switches l^1 and *m2a*.

Another improvement in the arrangement shown in the circuit diagram of Fig. 21, as compared with the arrangements shown in Fig. 1, consists in that the pick-up Q for communicating messages prepared by the called subscriber to a calling subscriber and/or the signalling means (siren S or the like) are not simply short-circuited by the switches *m3* and *m4* respectively, but are shunted by potentiometers P_3 and P_4, respectively, whereby the sound intensity communicated by these auxiliary devices to the calling subscriber is regulable.

A further modification consists in that the switch *m5* of the arrangement shown in Fig. 1 is omitted in the arrangement shown in the diagram of Fig. 21. The exchange line circuit may also be coupled to the inlet circuit of the amplifier W by means of a transformer J, one terminal of which is connected to the frame of the amplifier and the other terminal to the contact *a* of switch *u7*. Contact *b* of this switch is connected as usual to the amplifier inlet IT, the other terminal of which is connected to the frame of the amplifier.

Contact *c* of switch *u7* is connected to one terminal of the recording and reproducing device D, the other terminal of which device is connected to contact *b* of switch *u8*, contact *c* of which is connected to the frame of the amplifier W. Accordingly, when the switches *u7* and *u8* are set to reproduction by means of the control handle, the recording and reproducing device D is connected to the inlet IT of the amplifier W.

As to the switches *u9* and *u10*, the contacts *b* thereof are connected as according to Fig. 1 to the output O of the amplifier W, and the contacts *c* are connected to the telephone receiver or loudspeaker T. The sound frequency modulated currents produced by the device D when picking-up the recorded messages are amplified by the amplifier W and reproduced by the telephone receiver or loudspeaker T.

When the switches *u7*, *u8*, *u9* and *u10* are set to their recording positions by means of the control handle, i. e. the contacts *b* are engaged with the contacts *a*, the incoming modulated currents are, as described hereabove, transmitted over the transformer J and switch *u7* to the amplifier inlet IT. The device D is, as explained here-

above, connected over switches *u9* (*a*—*b*) and *u10* (*a*—*b*) to the amplifier outlet O, and is shunted over switch *u8* (*a*—*b*) over a potentiometer P_8 serving as regulating means for varying the intensity of the sound frequency modulations to be recorded.

The mechanical arrangement comprises:

The motor M driving the gear of the apparatus and certain auxiliary devices, namely

(*a*) A sound record prepared by the called subscriber for communicating a message to the calling subscriber and the control of a pick-up Q therefor,

(*b*) A recording medium and recording and pick-up means therefor,

(*c*) A control shaft or shafts for automatically engaging and disengaging certain mechanical elements, and switching on and off certain circuits during the cycle of operations corresponding to the "recording" (I) and to the "reproducing" phase (III), respectively,

(*d*) Devices for counting the number of messages, and for positioning the recording stylus or other device and reproducing pick-up means to the appropriate place with respect to the recording medium, and switching off the apparatus after reproduction of the last record or when the capacity of the recording medium has been exhausted.

These mechanical arrangements will first be described with reference to the "recording" phase (I). Referring now to Fig. 6 a control shaft 1 is shown as being coupled by means of the general control handle U to a motor driven shaft 2 so as to make one revolution during one "recording." On shaft 1 are provided several cams only one of them, 3, being shown in the drawings (cam 4 serving for use during "reproduction," will be described later). The cams not shown serve for the control of certain switches such as *m1* or *m2* as will be described more fully in connection with these switches.

The cam 3 acts on a slidably or tiltably arranged member 5 which will be referred to shortly as the slide 5. On the inner side of said slide are provided two wedge shaped faces 6 and 7 respectively each of which cooperates with a pair of scissors-like levers 8, 9, and 10, 11, respectively, which are normally closed by the springs 12 and 13, respectively, so as to bring rollers 14, 15, and 16, 17, provided respectively at the ends of levers 8, 9, and 10, 11, into engagement with a roller 18 driven by the motor (M, Fig. 1) and either one of two rollers 19 and 20, connected respectively to two reels on which the recording medium is wound.

Depending upon the position of the slide 5, at least one pair of coupling rollers 14, 15, or 16, 17 are disengaged by the action of the wedges 6 and 7, respectively.

The slide 5 is biased by a spring (not shown) to contact with the cam 3 during recording. This cam is so shaped that during its rotation, the slide 5 remains in its mid position, but as soon as the apparatus is ready for actual recording, the slide 5 is moved to the right (in Fig. 6) so as to bring the wedge 7 out of engagement with the levers 10, 11 which consequently are closed by the spring 13.

The rotation of the roller 18 is thus transmitted to the reel connected to the roller 20, whereby the tape recording medium is wound onto this reel from the reel driven by the roller 19 passing over a roller 21 whereon it is exposed to a recording stylus 22 of the electroacoustic system (D, Fig. 1).

The surface of the roller 21 is acoustically insulated with respect to its axis by an intermediate layer of sound proof material. This roller may be forced by a spring 23 against the stylus 22 of the electroacoustic system.

As in this embodiment the individual records are recorded in parallel tracks on a tape of finite length which—allowing for fixture, and starting and stopping—is approximately equal to the average length of the individual message records, the recording medium must be wound back when the record is terminated in order to be ready for the recording of the next record. This winding back is effected in the following way: after a predetermined number of revolutions of the driving motor (M, Fig. 1) corresponding for example to the termination of the actual recording, the shaft 1 has been turned so far that cam 3 allows the slide 5 to be shifted to the left, so that the levers 10, 11 are "opened" by the wedge 7 and the coupling between the motor driven roller 18 and the reel roller 20 is disengaged. Simultaneously the roller 18 is coupled by means of the rollers 14, 15 to the reel roller 19 so that the record tape is wound back from the reel driven by roller 20 onto the reel driven by roller 19.

The levers 8, 9 are connected by means of a link 24 to a lever 26 supporting the bearings of roller 21 which is thus withdrawn from the stylus 22 before the rollers 14, 15 establish coupling between the reel roller 19 and the motor driven pulley 18. A knife edge 25 may serve as a fulcrum for the lever 26 and the roller 21 is moved against the bias of the spring 23. Alternatively, the stylus 22 may be lifted away from the roller 21 by means of the link 24.

In addition to winding back the recording medium, a transverse movement of the recording stylus 22 with respect to the recording medium must be effected prior to the next actual recording, in order that the next record shall be made parallel to the foregoing one. This is effected by a device shown in Figs. 2 and 4.

The shaft 26 of reel roller 19 is equipped with a toothed wheel 27 which meshes with another toothed wheel 28 slidably mounted on a shaft 29 and is biased by a spring 30 to the left (Fig. 2).

The toothed wheel 28 is connected to an arm 31 supporting a pin 32 for rotating a Geneva wheel 33 which provides a step-by-step motion gear for lateral shifting of the stylus 22. For each revolution of the toothed wheel 28, the Geneva wheel 33 is rotated through one step, and between successive movements, it is fixed by engagement of a cylindrical member 34 carrying the arm 31 which cylindrical member engages in one of the concave portions of the Geneva wheel.

The ratio between the gear wheels 27 and 28 is such that for each winding back of the recording medium on to the reel driven by roller 19, the Geneva wheel 33 is moved one step. (Instead of being driven from the shaft 26, the arm 31 may equally well be controlled directly from the control shaft 1 (Fig. 6) for example by means of cams, levers, toothed gears or the like).

The Geneva wheel 33 is mounted on a shaft 35 which is journalled in the hollow end of a threaded spindle 36. By means of a spring 37 a toothed wheel 38 slidably mounted by means of a key 39 on the hollow end of shaft 36 (see also Fig. 4) is forced to the left (Fig. 2) so that an extension 40 on the toothed wheel 38 engages a hole in the Geneva wheel 33 and thereby tempo-

rarily couples the Geneva wheel with the shaft 36.

On this threaded shaft 36 is provided a nut 41 which is connected with, but acoustically insulated from the electroacoustic system (D, Fig. 1). Upon each step of the Geneva wheel 33 which as described above, is effected at the end of each winding back of the recording medium, the stylus 22 of the electroacoustic system is moved one step transversely of the recording medium so that this tape medium is covered successively by sound records recorded in parallel grooves.

In order to prevent the Geneva wheel 33 from being moved backward, whilst the recording medium is being wound back onto the reel driven by roller 20, i. e. during reverse rotation of the shaft 26, the spring 30 is provided to force the toothed wheel 28 and the arm 31 to the left so that the pin 32 is brought out of engagement with the Geneva wheel 33. On the other hand, in order to couple the Geneva wheel 33 to the member 34 during winding of the recording medium onto the reel driven by roller 19, the member 34 is forced, against the action of spring 30, into engagement with the Geneva wheel 33 by means of a lever 42. This lever is controlled by a cam 43 which is connected to a toothed pinion 44 and is held in operative engagement with the lever 42 by means of a spring 45. The toothed pinion 44 meshes with a toothed rack 46 which is oscillated by the reciprocating movement of the slide 5 (Fig. 6). Alternatively, the rack 46 may be controlled by a cam (not shown) on the control shaft 1 (Fig. 6).

Depending upon the position of the slide 5, the cam 43 is positioned so as to press the lever 42 against the member 34 as long as the reel driven by roller 19 is coupled with the motor driven roller 18, and is in a position so as to allow the lever 42 to come out of engagement when the reel driven by the roller 20 is rotated.

In order to prevent the Geneva wheel 33 from being rotated unintentionally when the pin 32 on member 34 is out of engagement with it, the member 34 is provided with a lateral extension so as to form a complete cylinder which engages one of the concave recesses of the Geneva wheel 33 during the entire rotation of the member 34.

As described hereabove the Geneva wheel 33 is coupled with a toothed wheel 38 by engagement of a lateral pin 40 into a hole by the action of a spring 37. This toothed wheel 38 meshes with another toothed wheel 47. As each step of the Geneva wheel corresponds to one winding back of the recording medium, such a step constitutes the unit of a metering or counting device formed by or connected to said toothed wheel 47.

The toothed wheel 47 is connected to a spring which is preferably arranged within said wheel, and is tensioned by the step-by-step motion of the Geneva wheel. As will be described more in detail in connection with the reproduction of the records, the force of this spring is used for moving the electroacoustic system backwardly transversely of the recording medium, the electroacoustic system being connected as described with the nut 41 on the threaded spindle 36 which is coupled with the toothed wheel 38 meshing with the toothed wheel 47.

On a fixed shaft 48 for the toothed wheel 47, is rotatably mounted a disc 49 having laterally projecting pins 50 and 51. The projection 50 is engageable in a single hole provided in the lateral face of the toothed wheel 47, and the projection 51 is engageable in one of a series of holes 53 in a plate 52 (see also Fig. 3), which is held against rotation in order to arrest rotation of the disc 49 when coupled therewith. This plate 52 is laterally slidable so that it can be brought out of range of the projection 51 for a purpose which will be described more in detail in connection with the reproduction of the records.

The disc 49 is furthermore provided at its periphery with two radial extensions 54 and 55 which may bear on projections 56 and 57, respectively, extending laterally from the toothed wheel 47 and the frame 58. As will be described in greater detail in connection with the reproduction of the records, the projection 57 serves as a fixed starting point for the movement of the recording and the reproducing pick-up means, transversely of the recording medium, and the projection 54 serves as a movable starting point, in order that reproduction may be started from the commencement of the first record which has not already been reproduced, and continue recording from the end of the last record reproduced.

By means of a bell-crank lever u59 operated by the general control handle U, the disc 49 may be shifted axially in one direction so that the pin 50 projecting laterally therefrom may engage the hole in the toothed wheel 47 or in the other direction so that the pin 51 may engage one of the holes 53 in the plate 52. Each of the holes 53 in plate 52 corresponds to a longitudinal zone of the recording medium and between the last and the first holes (53b and 53a, Fig. 3) is a sector to allow for the projections 54 and 55 of the disc 49 and the projections 56 of the toothed wheel 47, and disc 57 of the frame 58.

The ratio between the gears 38 and 47 is such that the hole in the toothed wheel 47 aligns with the last hole 53b in the plate 52 when the capacity of the recording medium has been exhausted.

The operation of the device is as follows: preparatory to recording, the operator by setting the general control handle U to its "recording" position (I), moves the disc 49 through the bell-crank lever u59, to its right hand position so that its projection 51 engages one hole 53 in the plate 52, whereby the disc 49 is prevented from rotating.

In the case of a first record on a new recording medium, the projection 51 is engaged in the first hole 53a of the plate 52. In this position, the lateral projection 50 of the disc 49 is disengaged from the single hole in the toothed wheel 47. The peripheral projections 55 and 54 on the disc 49 bear respectively on the projections 57 of the fixed frame 58 and on the projection 56 on the toothed wheel 47. When the latter is caused to rotate by the toothed wheel 38, due to the movement of the Geneva wheel 33, the projection 56 on the toothed wheel 47 moves away from the projection 54 on the disc 49, which latter is fixed against rotation during this phase. For each record the toothed wheel 47 is rotated through an angle corresponding to the pitch of the holes 53 in the plate 52.

As will be described in greater detail with reference to the reproducing phase (III), the device is set to the position corresponding to the first hole 53a in the disc 52 for reproduction of the first series of record. After reproduction of the last record of this series, it is again in the position where it was after recording of the last record.

When the device is again adjusted for recording, the disc 49 is again moved to the right until

the lateral pin 51 therein engages the hole in the plate 52 corresponding to the number of records which have been already reproduced. The new incoming calls cause further step-by-step movement of the Geneva wheel 33, and accordingly of the toothed wheel 47, the spring connected to which is further tensioned, and the projection 56 on which is again removed from contact with the projection 54 on the disc 49, which disc is now in a position corresponding to the commencement of the unused space on the recording medium, i. e. immediately adjacent to the last recorded record. Thus the projection 54 constitutes a movable starting point.

When another set of messages has been recorded on the recording medium, the movable starting point 54 is again displaced, and recording of a fresh series of records begins from the new position of the projection 54 until the record tape has been recorded on over its entire width, i. e. until its recording capacity is exhausted.

When this capacity is very large, so that the ratio of the gears 38 and 47 becomes abnormally high, the projection 56 may be provided on a planet wheel (not shown) instead of on the toothed wheel 47, whereby the ratio between the wheels 38 and 47 may be reduced to a practical value.

On the other lateral face of the toothed wheel 47 a further projection 60 is provided which operates the switch *c7* (see also Fig. 1) when the toothed wheel 47 is rotated further by the operation caused by a new incoming call, after the last record for which there was a space available on the recording medium, has been recorded. This switch *c7* is normally closed and is opened by the projection 60 so that all the circuits of the device which are connected to the public supply mains N are interrupted and the device as a whole is rendered inoperative on further incoming calls.

When after one or a series of calls have been recorded, the subscriber wishes to attend personally to incoming calls (for example after having returned from an absence), the general control handle U must be set to its "intermediate" position (II). The switch *u1* is thereby set to *bc*, the apparatus thus disconnected from the exchange lines AB and the subscriber's station Y connected to the exchange lines. By setting the general control handle U to the "intermediate" position the condition of a number of other switches may or may not be altered to prepare them for subsequent reproduction. For example, the switches *u6* and *u2* may be opened already by setting the general control handle U to the "intermediate position" because this has no influence on the operation of the apparatus in this phase. The switches *u3* and *u4* must not, however, be closed in this position of the general control.

If now the subscriber wishes to reproduce any of the records made during his absence, he sets the general control handle U to the position for "reproduction" (III), whereby the switches *u7*, *u8*, *u9* and *u10* are set to *bc*, the reproducing pick-up D is connected to the input IT of the amplifier W and the receiver or loudspeaker T is connected to the amplifier output O. This setting of the contacts *u7*, *u8*, *u9* and *u10* may alternatively be effected when the general control handle U is set to the "intermediate" position.

If the switches *u6* and *u2* have not been opened by setting of the control handle to the "intermediate" position (II), they must be opened now by setting the control handle U to the "reproducing" position (III), and at the same time the switches *u3* and *u4* must be closed. Switch *c6* being normally closed, a current now passes from the public supply mains N through switch *u3* to the amplifier W and through switch *u4* to a thermal switch Z which closes switch *z1* and thereby starts the motor M after a time delay corresponding to the time required for heating the cathodes of the amplifier valves up to emission temperature.

The thermal switch Z and the switches *z1* and *u4* may be dispensed with when amplifier valves are used which attain their emission temperature at once, or when an electroacoustic system is used with the pick-up D which produces audible modulated currents without requiring any amplification.

As will be more fully described with reference to Fig. 5, switch *c6* is opened automatically as soon as the reproduction of the last record has been completed, and all circuits connected to the public supply mains N are thereby interrupted.

Referring now to Fig. 6, by setting the general control handle U to the "reproduction" position (III) the control shaft 1 is coupled to the shaft 61 which is also driven by the motor M, but preferably the ratio of gearing between the shaft 1 and the shaft 61 is different to that between shaft 1 and shaft 2. One revolution of the control shaft 1 corresponds to the duration of one "recording" (I) or "reproducing" (III) operation and these durations are generally of different length for the following reasons:

Primarily, the current supplied from the public supply mains N to the amplifier W is generally an alternating current and an appreciable lag of time is thus required for heating up the cathodes of the valves to emission temperature. Generally the individual records are recorded at comparatively long intervals so that the amplifier valves will require heating-up anew each time a call is made whereas the records will generally be reproduced one immediately after the other so that one heating-up of the amplifier valves is sufficient for a plurality of reproduced records.

Secondly, in most cases it will be necessary to inform the calling subscriber that his messages will be recorded, to allow him time to formulate his message and finally to advise him that the apparatus is prepared for recording. During the heating-up time of the amplifier valves, the signs, signals or informations may be given to the calling subscriber, so that this lag of time is usefully employed. In reproduction such information and the like is not required.

Accordingly it is advisable to include the heating-up time of the amplifier valves in the "recording" cycle for each call but not in the reproducing cycle. This can be achieved by starting the motor for recording while the amplifier is still being heated-up whereas for reproduction the motor is not started before the amplifier valves have reached their emission temperature. Consequently the duration of reproducing is different from that of recording.

On the control shaft 1 is provided a second set of cams for reproduction of which the cam 4 only has been represented in Fig. 6. This cam acts on the slide 5, in a similar manner as described with reference to cam 3 for recording.

Instead of using one control shaft 1 with two sets of cams, two different control shafts may be used, one for "recording" (I) and one for "reproduction" (III). On the other hand when the duration of the two periods is made equal, a single control shaft 1 may be used which is permanently coupled to the driving motor M. Also if the length of both operations happens to be the same, a single set of cams would suffice.

For the actual reproduction of each individual record, the reel driven by the roller 19 is coupled to the motor driven roller 18 by the coupling rollers 14 and 15, and for winding back the recording medium preparatory to the reproduction of the next record, the reel driven by the roller 20 is coupled to the roller 18 by means of the coupling rollers 16 and 17, depending upon the different positions of the slide 5 which is controlled by the cam 4 exactly as described with reference to cam 3 for recording. There is, however, the general difference that the apparatus is switched off after recording each individual call by opening switch *m*1 (Fig. 1) in order to prepare the apparatus for receiving the next incoming call, whereas it is not necessary to switch off the apparatus after reproduction of each individual call, so that after completion of one revolution the shaft 1 continues to rotate thereby automatically effecting the "reproduction" of the next record. This can be effected satisfactorily since suitable intervals are provided between the actual reproduction of successive records due to the rewinding of the recording medium, the length of which in this embodiment, as already mentioned, corresponds to that of each individual record. As will be described with reference to another embodiment where no intervals are provided between reproduction of successive records, due to the nature of the recording medium, "reproduction" (III) may be stopped automatically after the reproduction of each individual record. This difference is, as will be understood, merely for convenience and is not essential for the operation of the apparatus according to this invention.

As recording is made by mechanically engraving, in the embodiment now under consideration, a needle 62 (see Fig. 6) is connected to the electro-acoustic system D for reproducing. By the general control handle U, this pick-up needle 62 is brought into operative position with respect to the recording medium instead of the stylus 22 when the apparatus is switched from the "recording" position (I) to the "reproducing" position (III). The pressure of the spring 23 may also be reduced, but when the pick-up needle 62 is so arranged as to yield in the direction of the pressure of the spring 23, this adjustment may be dispensed with. It will be understood that these settings may be effected by the setting of the general control handle U to its "intermediate" position (II).

Referring now again to Figs. 2 and 4, the operation of the mechanism represented corresponds generally to that described in connection with the "recording" (I). During each winding back of the recording medium preparatory to the reproduction of the subsequent record, the Geneva wheel 33 is moved one step and the pick-up means which is connected to the nut 41 on the threaded spindle 36 is moved transversely to the recording medium so as to be correctly positioned on the next succeeding parallel record. During actual reproduction the arm 31 is disengaged from the Geneva wheel 33, as described hereabove, by the cam operated mechanism 46, 44, 43 and 42, the cylindrical member 34 preventing reverse rotation of the Geneva wheel 33.

The action of the cam 43 on the lever 42 can be prevented during winding back of the recording medium preparatory to the next reproduction by depressing a button 63. The Geneva wheel 33 is thus not moved and the pick-up remains in operative position with respect to the last reproduced record, the reproduction of which is thereafter repeated as long as the cam 43 is held out of engagement with the lever 42.

The cam 43 remains in its lower position after the pressure applied on the button 63 is relieved since it rotates under the lower end of the lever 42 whereby it is prevented from being raised by the spring 45. When the cam 43 has rotated clear of the lower end of lever 42 it is returned to its upper position by the spring 45, and on further rotation, it rocks the lever 42 so that the apparatus proceeds to the reproduction of the next record. However, by again depressing the button 63, each record can be repeated as often as desired.

The step-wise motion of the Geneva wheel 33 which corresponds to the lateral movement of the pick-up from one record to the next, also rotates the wheel 47 which accordingly counts the individual reproductions in the same manner as it counts the individual recording.

Before reproduction can commence, the electro-acoustic device which is connected to the nut 41 on the threaded spindle 36 must be positioned from the last recorded record to the first one the reproduction of which is desired. To this purpose by setting the general control handle U to its "intermediate" position (II), the toothed wheel 38 is disengaged from the Geneva wheel by means of the bell-crank lever *u*64. Consequently the spring connected to the toothed wheel 47 is released, and thus turns the wheel 47 and the wheel 38 which meshes with it, in the inverse direction whereby the shaft 36 is rotated and the nut 41 and the electroacoustic system connected thereto is moved backwardly until the projection 56 on the wheel 47 comes to rest against the projection 54 on the disc 49.

In order to ensure that the tension of the spring connected to the toothed wheel 47 is sufficient to drive the pick-up back to its initial position opposite to the first record, it is advisable to impart a preliminary tension to this spring. It will be seen, however, that the pick-up is not always set to the commencement of the first record on the recording medium, but to the first record not yet reproduced on a previous occasion.

When the apparatus is set to "reproduction" (III) by the general control handle U, the disc 49 is shifted to the left and the lateral projecting pin 50 thereon is engaged in the hole of the wheel 47. When actually reproducing the individual records, the recording medium is wound back onto the reel driven by the roller 19 (Fig. 6) which is mounted on shaft 26 and consequently the toothed wheel 47 is again moved stepwise by means of the gear 27, 28, the arm 31, the Geneva wheel 33 and the toothed wheel 38, and this time the disc 49 is coupled to the wheel 47 so as to be rotated therewith. The radial projection 55 on the periphery of the disc 49 accord-

ingly moves away from the abutment 57 on the fixed frame 58, which abutment serves as a fixed starting point.

As described above with respect to recording (I), the disc 49 is again shifted by the bell-crank lever u59 to its right hand position when after reproduction of the first series the apparatus is again set by the control handle U for "recording" (I). The lateral projection 51 thereon thus engages in the hole 53 in the plate 52 which corresponds to the number of records in the first series. When after recording of a second series of records the general control handle U is set to its "intermediate" position (II), and the wheel 47 is released so as to rotate in the reverse direction under the influence of the spring connected thereto, the projection 54 on the periphery of the disc 49 is in a position corresponding to the hole 53 engaged by the projection 51, and the wheel 47 therefore does not rotate back to its initial position but only until the projection 56 abuts against the projection 54 on the disc 49.

If the apparatus is again set to "reproduction" (III) by the general control handle U, reproduction starts from this new position of the stop 54 which is the movable starting point, and the first record of the new series is thus the first one to be reproduced.

These cycles are repeated on each occasion that a new series of records is made and reproduced. When finally the capacity of the recording medium is exhausted the apparatus is switched off by means of the switch c7, which is opened by an abutment 60 on the wheel 47 in a known manner, as described hereabove. In order to render the apparatus again operative, the recording medium must be exchanged and the apparatus must be reset to its initial position where the stylus 22 of the electroacoustic system is in alignment with the zone on the fresh recording medium where the first message is to be recorded.

To this purpose, the shaft 36 is released from the Geneva wheel 33 by withdrawing the pin 40 of the wheel 38 therefrom, the projection 50 on the disc 49 is disengaged from the hole in wheel 47, and the plate 52 is shifted to the right so that the right hand pin 51 of the disc 49 does not engage any hole of this plate. All these movements are preferably caused by setting the general control handle U to a fourth position which will be referred to hereinafter as the "change" position (IV.)

Consequently the wheel 47 rotates in the reverse direction under the influence of its associated spring, the projection 56 thereon carrying with it the projection 54 on the disc 49 until the projection 55 on the latter bears against the abutment 57 on the fixed frame 58, i. e., against the fixed starting point.

The toothed wheel 47 serves as a counting mechanism or as a plurality of counting mechanisms whereby complete automatic functioning of the apparatus is obtained. The angular displacement of the latter bears against the abutment 57 of the fixed frame 58 (i. e. the fixed starting point) indicates the total number of records recorded or reproduced or the total length of them, while the angular displacement of this projection 56 from the projection 54 on the disc 49 (i. e. the movable starting point) indicates the number of length of records recorded but not yet reproduced.

In order to render the apparatus completely automatic however, the further function of disconnecting the apparatus from the public supply must be performed automatically. In previous arrangements, switching-off is only effected when the recording medium has reached one of its end positions i. e. either when its capacity has become exhausted or when it has been fully wound back. In carrying out the invention, either a single counting mechanism may be arranged which for recording is moved one way and for reproduction is moved in the reverse direction, cutting out the apparatus as soon as it has returned to its initial position, or two separate counting mechanisms are used, one of which moves during "recording" only, whereas the other one moves during "reproducing" only and in the same direction as the first one moves during "recording," switching off the apparatus as soon as it has reached the position reached by the first one.

Apart from their function as automatic switching off means, these counting mechanisms may also serve to indicate visually to the subscriber the number of records not yet reproduced i. e. before reproduction of the last series of recorded records has been started the total number of this series and during reproduction the number awaiting reproduction.

In Figs. 1 and 5 the electrical connections and the mechanical arrangement are shown of an embodiment of a counting mechanism moving in one direction for "recording" (I) and in the reverse direction for "reproduction" (III).

In the direct current circuit+—of the amplifier W, a switch u5 is provided which is set to *ab* for "recording" (I) and to *bc* for "reproducing" (III) by means of the general control handle U. To the contacts *a*, *c*, respectively of this switch electromagnets 65 and 66 respectively are connected, which actuate oppositely toothed ratchet wheels 69 and 70 through pivoted levers 67 and 68, respectively. These ratchet wheels are connected with one another, and to a wheel 71 and to a switch actuating cam wheel 72. The periphery of the wheel 71 is formed with a plurality of semicircular recesses 73 which are equally spaced at the same pitch as the teeth of the ratchet wheels 69 and 70. A spring latch 74 successively engages the recesses 73 of the wheel 71 and thereby prevents unintentional rotation thereof. However, when either of the two ratchet wheels is turned by its respective electromagnet, the spring latch 74 is raised from the wheel 71 due to the semicircular form of the recesses.

The periphery of the operating cam wheel 72 is formed at one point only with a semicircular recess 75, and on the periphery of the wheel slides a curved feeler 76 of the switch c6. This switch is normally closed and is opened only when the feeler 76 engages in the recess 75.

When the apparatus is set for "recording" (I), the switch c6 is shunted by switch u6 (Fig. 1). This is necessary because the cam wheel 72 is so adjusted that in the position prior to the first recording, the feeler 76 is in the recess 75 and the switch c6 is accordingly open. For each step of the counting mechanism (i. e. when actually recording or reproducing one individual record) a switch mII arranged in the direct current circuit+—, which may be controlled by an abutment 77 on the Geneva wheel driving member 28 (Fig. 2) is temporarily closed. In the "recording" phase when switch u5 is set to *ab*, by closing the switch mII the electromagnet 65

is energized and thereby the ratchet wheel 69 is turnd one tooth. The feeler 76 of the switch *c6* is accordingly raised from the recess 75 in the wheel 72, and switch *c6* is closed.

Upon recording of each subsequent record, this process is repeated while the feeler 76 remains on the periphery of the wheel 72 outside the recess 75 so that the ratchet wheel 69 and the wheels 70, 71 and 72 which are rigidly connected thereto are rotated through a number of teeth from their initial position corresponding to the number of messages recorded.

When the apparatus is set for "reproduction" (III) switch *u6* shunting switch *c6* is opened by the general control handle U so that the current from the public supply mains N can pass to the apparatus only through the switch *c6*. At the same time the switch *u5* is set to *bc*. When now switch *m*II is temporarily closed upon reproduction of each individual record, the electromagnet 66 is energized and thereby the ratchet wheel 70 is moved one tooth each time, in the inverse direction to the rotation of the ratchet wheel 71 when recording. Consequently after the reproduction of the last record, the system of wheels 69, 70, 71, 72 returns to its initial position and the feeler 76 for switch *c6* drops into the recess 75 on the periphery of the wheel 72 thus opening switch *c6* and interrupting the connection of the apparatus with the public supply mains N.

When the reproduction of an individual record is to be repeated, the counting mechanism after repetition, must be in the same position as it is after the first reproduction. In the embodiment hereinbefore described, this is obtained by preventing the switch *m*II from being closed upon repetition. To this purpose in the embodiment as represented in Fig. 2 the switch *m*II is controlled by an abutment 77 on the toothed wheel 28 which is shifted to the left for repetition so that the abutment 77 does not engage the switch *m*II nor does the pin 32 engage the Geneva wheel 33. Thus the counting mechanism is not operated during repetition, and the pick-up is not set transversely.

The modified arrangement shown in Fig. 7 is distinguished from that shown in Fig. 1 as follows:

The direct current circuit of the rectifier 122 is also utilised during the reproduction phase for example to supply the electromagnets 65 and 66 of the counting mechanisms serving to switch-off the apparatus after reproduction has been completed. Accordingly provision is made so that the motor circuit is closed when switch *ha2* is closed on energisation of the relay HA, and not by setting the general control handle U to its "reproduction" position (III), (as in the embodiment shown in Fig. 1). To this purpose a third branch of the motor circuit is arranged in parallel with the two other parallel branches one of which includes the switches *c7* and *h1* in series with one another and the other of which includes the switches *m1* and *ha1* also in series, exactly as with the embodiments as shown in Fig. 1.

The third branch, however, comprises switches *u3a* and *c6a* corresponding in function to the switches *u3* and *c6* respectively of the diagram shown in Fig. 1. Switch *c6a* is controlled by the counting mechanism 65, 66, switching off the apparatus when the reproduction of all records is over, and switch *u3a* is controlled by the general control handle U so as to be closed when the handle is set to its "reproduction" position (III).

Switch *u6* of the diagram in Fig. 1 has been omitted from the diagram in Fig. 7. Switch *c6a* is shunted by the switches *m1*, *ha1* and *c7*, *h1* respectively in the two other parallel branches.

Switch *u2* in the embodiment shown diagrammatically in Fig. 1 is provided with three contacts *a*, *b*, *c* serving concurrently to connect the motor M and the amplifier W to the public supply mains N during the "recording" phase (I) and to separate the motor and the amplifier circuit from one another during the "reproduction" phase (III). In the embodiment shown in Fig. 7 this switch *u2* has been replaced by a simple switch *u2a*, which is controlled by the general control handle U so as to be closed for "recording" (I) and opened for "reproducing" (III).

In this modified embodiment of the apparatus, the amplifier W is directly connected to switch *ha2* of the relay HA both for "reproduction" (III) and for "recording" (I). No further switch is required in this circuit which is closed immediately by relay HA when "recording" (I) or "reproducing" (III) is being initiated.

Switch *u2a* is included in the motor circuit only and, for "reproduction" (III), the motor circuit must not be closed before the amplifier valve cathodes have been heated-up to emission temperature. Switch *u2a* is therefore opened for "reproduction" (III) by the general control handle U as set forth above. The switch *u2a* is shunted by a switch *za1* which is closed by a relay ZA energised by the plate current of a suitable valve of the amplifier W. This new switch *za1* replaces switch *z1* of the arrangement shown in Fig. 1, which is closed by a thermal switch Z.

The ohmic resistance and the impedance of relay ZA are so arranged that it either does not interfere with the characteristics of the amplifier circuit or else it forms one of the elements thereof.

Switch *u4* in the arrangement shown in Fig. 1 has been omitted from the modified embodiment of Fig. 7.

An additional switch *y1* is included in the motor circuit of the modified embodiment and is opened manually by means of a separate key or by lifting off the receiver of the subscriber's station Y for the purpose of interrupting the series of reproductions.

As already pointed out above, the electromagnets 65 and 66 of the counting mechanisms which switch off the apparatus after reproduction of the last record, are connected in this embodiment to the rectifier 122 as also are the switches *u5* and *m*II.

A further modification has been developed out of the following considerations: when the winding to-and-fro of the recording medium is not effected very precisely, the point of commencement of reproduction may not always coincide exactly with that of recording. Though these differences may be negligible for one individual record they are liable to accumulate to an appreciable difference with many records. These differences are greatest when the motion of the element from which the control of the winding to-and-fro of the recording medium is derived is slowest, as it is impossible to machine the cams 3 and 4 with sufficient exactness. The control of the winding to-and-fro of the recording medium is effected by the control shaft 1 or shafts which perform one revolution only during each recording or reproducing and accordingly move very slowly. The difficulty has been overcome now in the following manner:—

Instead of terminating the winding motion of the reel of the recording medium by mechanically disengaging the respective coupling rollers 16, 17, or 14, 15 as represented in Fig. 6, after a predetermined number of revolutions of either the driven or the driving rollers, this can be effected electrically as soon as a predetermined length of the recording medium has been moved.

The circuit diagram of such an arrangement is shown in Fig. 7 and a constructional embodiment is shown in Fig. 8. An electromagnet MG is connected to the public supply mains N in parallel with the motor M. This electromagnet when energised disconnects the coupling between the motor M and the driven reel. The circuit of this electromagnet MG is controlled by a switch *h*IV operated by a relay HB which is connected to a low tension circuit, preferably the circuit of the rectifier 122. In this circuit are provided two switches *m*V and *m*IV arranged in series. Switch *m*V is closed temporarily by two contacts or conductive layers which are preferably arranged at the lower side of the recording medium, the distance between which contacts or conductive layers corresponds to the time period during which the apparatus is ready for actual recording.

As such contact layers must be of a certain minimum length in order to ensure a positive contact, it may happen that the recording medium comes to rest when one of the conductive layers is still closing switch *m*V. The switch *m*VI is therefore arranged in series with switch *m*V and is normally open, being closed only temporarily when establishing a coupling connection between one of the reel driving rollers 20 or 19 and the driving motor roller 18.

The slide 5 (Fig. 6) has been replaced in the arrangement shown in Fig. 8 by a balance arm 5*a* and carries the coupling rollers 16 and 14 for alternately coupling the motor driven friction roller 18 with the friction reel-driving rollers 20 and 19 respectively.

A forked lever 78 is journaled to the frame 79 of the apparatus and is provided with springs 80 and 81 to which the rear end of the balance member 5*a* is connected. The other arm of the lever 78 is equipped with two plates 82, 83 extending laterally therefrom.

The control shaft 1 passes through a slot 84 in the lever 78 and carries a disc 85 having two pins 86 and 87 arranged at different radial distances from the center of the shaft 1 and extending laterally at different lengths from the disc 85 so as to engage respectively the plates 82 and 83 on the lever 78.

The outer pin 86 is shorter than the inner one 87 in order to pass by the longer plate 83 and to engage the plate 82 only. Upon rotation of the shaft 1, the end of lever 78 is accordingly raised and lowered by engagement of the plates 82 and 83 with the pins 86 and 87 respectively.

The rear end of the lever 78 is wedge-shaped and engages a dove-tail shaped extension 88 on the armature 89 of the electromagnet MG. This armature is held resiliently against the end of the lever 78 by means of a spring 90.

When the wedge-shaped end of the lever 78 is raised or lowered by the action of the pins 86 or 87, on the plates 82 or 83, respectively, the dove-tail shaped extension 88 is first moved against the action of the spring 90 towards the magnet MG, and then returns under the influence of the spring to its right hand position, either below or above the end of lever 78, thus locking the same in a raised or lowered position, even after the pins 86 or 87 have moved out of engagement with the plates 82 or 83 respectively.

In this position, the lever 78 through the spring 80 or 81, respectively, raises or lowers the left hand end of the balance arm 5*a*, whereby the coupling roller 16 or 14, respectively, is brought into engagement with the friction roller 18 on the motor driven shaft and with the roller 20 or 19, respectively, driving the shafts of the reels.

Simultaneously the contact *b* of switch *m*VI is brought into contact with either contact *a* or *c* of this switch, whereby the electromagnet MG is energized as soon as the switch *m*V is also closed by the conductive layer on the recording medium as explained above. Thereupon, the armature 89 of the electromagnet MG is attracted thereto, so that the wedge-shaped end of lever 78 is released, and this lever and the balance arm 5*a* can thus return to their central positions under the action of the spring 80 or 81, respectively, disconnecting the coupling between the motor driven roller 18 and the reel driving roller 20 or 19, respectively, and opening switch *m*VI.

The circuit of the magnet MG is thus interrupted, and the armature 89 returns under the action of the spring 90 into a position where its dove-tail shaped portion 88 engages the wedge-shaped end of the lever 78, and the mechanism is again positioned to respond to the next action of one of the pins 86 or 87.

When the roller 20 or 19 is disengaged from the motor driven roller 18, the recording medium comes to rest either with its conductive layer still closing the switch *m*V whereby the electromagnet MG is energized immediately upon closing of switch *m*VI in series therewith, or with the conductive layer on the recording medium past the switch *m*V, in which latter case the conductive layer returns at the beginning of the subsequent reverse movement of the recording medium and then closes the switch *m*V. In either case the electromagnet MG would be energized too soon and the coupling of the rollers 20 or 19, respectively, would be broken immediately after having been established, and to prevent this, the plates 82 and 83 and the pins 86 and 87 are respectively arranged so as to remain in engagement until the conductive layer which stopped the last winding motion of the recording medium by closing switch *m*V has again passed this switch, whereby energizing of the electromagnet MG causes the lever 78 to be released only when the energization is effected by the conductive layer provided on the other end of the recording tape.

Further improvements of the apparatus shown in Figs. 1 to 6 relate to obtaining uniform tension of the recording tape throughout its winding motion in either direction. When one reel is driven and the other one runs idle, there is the danger of the tape being alternately stressed and slackened which is unfavorable both for recording and reproducing. This difficulty is overcome by arranging brakes on the shafts of the rollers 20 and 19 for the purpose of slightly retarding the rotation of the roller which is not coupled to the driving roller 18 for the time being.

Constant stressing of the recording tape may also be obtained by arranging a spring on roller 19 which is coupled to the motor driven roller 18 during winding back. On un-winding of the tape during recording the spring is tensioned so

that in order to wind-back it is only necessary to release the driven roller 19 from the driving roller 18 when the spring unwinds until the tape comes to rest at an abutment defining the starting position of the record. With such a system of winding and winding-back no differences between the amount of winding in either direction can arise.

This system of winding and winding-back of the tape is particularly applicable when recording and reproducing is effected magnetically (Poulson) and in such cases instead of using a single broad steel band or a broad band having magnetisable zones, several separate steel wires equal to the number of calls to be recorded may be employed. During recording and reproducing, such wires are wound on reels driven by a common shaft, whereas the reels on which these wires are wound back are provided each with a tensioning spring so that each wire is wound back independently from the others and each is stressed independently.

The same system is applicable when two tape-like sound record media are provided in order to utilise the full capacity of each tape, by exchanging one of the tapes when fully used up, while on the other there is still an unused portion.

When a plurality of reels are used they may all be arranged on a common shaft to which they are separately connected by torsion springs allowing limited angular displacement of the different reels with respect to one another, in order to avoid overstraining of one tape or wire while the other or others are slackened. This common shaft may be driven by a spring or by coupling it to the motor.

Instead of moving the pick-up or recording means transversely of the record medium by means of a threaded spindle (such as 36, Fig. 2) a cam having a spiral surface may be used, which when rotated with a step-wise movement moves the recording stylus and pick-up needle in a radial direction against the bias of a spring. The cam surface is shaped so that when the cam is rotated through equal angles, it moves the recording stylus and pick-up needle through equal transverse distances.

Such a cam arrangement is particularly advantageous when two sound record tapes are employed as mentioned above, because the transfer of the recording stylus and the pick-up needle from one tape to the other may be effected simply in a single step produced by a steep part of the cam surface.

The step-wise motion of the cam may be derived from the Geneva wheel 33, (Fig. 2) through a reduction gearing, or it may be obtained by providing a ratchet wheel on the cam shaft and rotating the ratchet wheel by a pawl constituting the armature of an electromagnet. In order to eliminate a second electromagnet and pawl for reproducing reverse motion of the ratchet wheel, the cam may be arranged for rotation always in the same direction, the outer end of the spiral curve being connected by a steep portion to the inner end thereof so that the recording stylus and pick-up needle are returned to their original positions after their maximum transverse displacement. This return movement may be suitably damped by a hydraulic or pneumatic dash-pot or like device.

In Figs. 9 and 10 of the drawings the cam is denoted by 136, a member connected to the recording stylus and pick-up needle by 141, a ratchet wheel connected to the cam by 170, two further ratchet wheels coaxially but independently mounted with respect to the wheel 170 (as will be described later in greater detail), by 149, 169, and a switch by 157, these references corresponding respectively to the references 36, 41, 70, 49, 69 and 57, denoting functionally equivalent parts in the arrangement shown in Figs. 2 and 5. Similarly, an electromagnet, the armature 167 of which acts as a pawl on the ratchet wheel 170, is referred to by 165. As, however, in this embodiment only one electromagnet is used to rotate the ratchet wheel 170 and cam (always in the same direction) this electromagnet 165 replaces both electromagnets 65 and 66 of Fig. 5 and also replaces the Geneva wheel mechanism 33 of Fig. 2.

The ratchet wheel 169 is connected to an insulating disc 92 carrying a switch c6 and two slip rings 93 for connecting this switch to one of the branches of the circuit of the primary transformer 121 (Fig. 7). This switch is normally closed unless it is opened by an insulating extension 172 which is connected to the cam 136.

The third ratchet wheel 149 is connected to an insulating disc 95 equipped with slip rings 96 and carrying a switch 157 which is also normally closed but may be opened by an insulating extension 98 provided on an insulating disc 99 on the upper side of the cam 136.

A further switch 100 is arranged with one contact on the insulating plate 99 on the upper side of the cam 136 and the other contact on the insulating disc 95 connected to the ratchet wheel 149.

In Fig. 11 the electrical connections of the mechanism shown in Figs. 9 and 10 are shown diagrammatically.

The circuit shown in Fig. 11 comprises two main branches which are alternatively switched in by connecting the contact *b* of a switch *u*11 to one or other of two contacts *a* and *c*. This switch *u*11 is controlled by the general control handle U so that during recording and reproducing, contacts *a* and *b* are connected together, while during readjustment of the recording stylus and pick-up needle to the beginning of the sound record not yet reproduced, contacts *b* and *c* are connected together.

In the branch connected to contact *a* are included two switches *m*IIA and 163 in series with one another. Contact *m*IIA is normally open, and is closed only temporarily once during each working operation, preferably near the end thereof. It may be controlled from the control shaft or from the recording tape winding mechanism in a manner similar to switch *m*II in the arrangement shown in Fig. 2, to which it corresponds.

Switch 163 is normally closed and is opened only when it is desired to repeat a record, in which case the branch of the circuit including this switch is interrupted and the electromagnet 165 prevented from being energised, so that the ratchet wheel 170 is not rotated further, and the recording stylus and pick-up needle are not moved by the cam 136. Switch 163 is controlled by a key corresponding to the button 63 shown in Fig. 2 and the switch is held open until switch *m*IIA has been opened again after its temporary closing, in a manner similar to that obtained by the mechanisms 38, 42, 43, 44, 45, 46.

In the branch connected to contact *u*11*c* there is provided a switch 157 and a magnetic hammer break 102 the electromagnet of which is denoted by 103 and the contact by 104. Switch 157 is normally closed (Fig. 11) and when switch *u*11 is set by the general control handle U to *b*, *c*, the

magnetic hammer break 102 provides electric impulses for the electromagnet 165 as long as switch 157 is closed.

Referring now to Fig. 10, a pawl *u12* is adjustable by means of the general control handle U to different positions as represented in detail in Figs. 10*a*, 10*b* and 10*c*.

In the "recording" position (I), the pawl *u12* acts on both of the ratchet wheels 169, 170 (Fig. 10*a*); on setting the control handle U to "reproduction" (III), the pawl *u12* acts first on the ratchet wheel 170 only (Fig. 10*b*) for readjustment of the pick-up needle to the beginning of the sound record not yet reproduced preparatory to actual reproduction and then for actual reproduction the pawl acts on the ratchet wheels 170 and 149 (Fig. 10*c*). Preferably switch *u11* is controlled by an extension on the pawl as shown in Figs. 10*a*, 10*b* and 10*c*, and accordingly this switch is indirectly controlled by the general control handle U as will be described more in detail hereinafter.

Therefore when "recording" (I) the ratchet wheels 169 and 170 are rotated through one step each time that the switch *m*IIA is closed. Consequently the cam 136 is rotated one step forward and the recording stylus is moved transversely to the place on the record tape where the next sound track is to be made. At the same time switch *c6* is rotated by the ratchet wheel 169 through the same angle as cam 136, so that this switch remains open.

When now the pawl *u12* is set into the position represented in Fig. 10*b* where it engages the ratchet wheel 170 only, and where its extension sets the switch *u11* to *b, c*, the pawl moves the cam 136 one step for every electric impulse of the magnetic hammer break 102 while switch *c6*, which is connected to the ratchet wheel 169 is not rotated. Consequently the insulating extension 172 on the cam 136 disengages switch *c5* which is thereby closed.

In this position the ratchet wheel 149 remains at rest in the position shown in Fig. 10*a*, so that switch 157 is again opened when the ratchet wheel 170 and cam 136 have returned to their initial position, i. e. when the pick-up needle is readjusted to the beginning of the sound record not previously reproduced.

When set to the position shown in Fig. 10*c*, the pawl *u12* engages both ratchet wheels 170 and 149, and the switch *u11* is set to *a, b*. Accordingly each time switch *m*IIA is closed, the cam 136 is rotated through one step forward and the pick-up needle is moved to the next sound track. By the rotation of the cam 136 the insulating extension 172 also approaches one step towards the switch *c6* (which during this period is at rest), so that switch *c6* is opened after a certain number of steps have been rotated through by the cam 136, corresponding to the number of calls which have been recorded, i. e. after reproduction of all calls.

For "repetition" of a call (III*a*), switch 163 is opened and in this case no rotation of the cam 136 is effected so that the pick-up needle remains in the same sound record track, and the extension 172 does not approach switch *c6*, whereby repetition of a call is not counted as a reproduction.

With apparatus using two sound record media one of which can be exchanged when fully used, it is not necessary to provide a device for readjusting the stylus to the first sound track when the band is exchanged as with an apparatus using only a single record medium.

Though with apparatus using two tapes it is not likely that the second medium will be exhausted before renewal of the first tape, this may occur after an exceptionally long absence of the subscriber, and in order to ensure switching-off of the apparatus in such an event, two switches *c7* and *c7A* are arranged in parallel (Fig. 10), so that the circuit is only interrupted when both switches are open at the same time.

The switches *c7* and *c7A* are normally closed, and are opened, according to the embodiment shown in Fig. 10 by an extension 105 of the disc 92 connected to the ratchet wheel 169. Means are provided to keep the switches *c7* or *c7A* open even when the extension 105 has passed the switch. When the recording medium is exchanged, the switches are mechanically released so as to be closed again.

Instead of mechanically passing the recording stylus and pick-up needle from one medium to the other by utilising a steep portion of the surface of the cam 136, a switch *c11A* may be arranged to shunt switch *m*11A (Fig. 11) which is repeatedly closed by a number of extensions on the cam 136 or on the ratchet wheel 170, so that the electromagnet 165 is repeatedly energised and causes a corresponding number of steps to be made by the cam 136.

A similar operation may be made at that part of the cam surface which connects the end of the spiral portion to its beginning in order to reduce the effect of the steepness of this part.

The control handle U has been described above in connection with the various parts controlled thereby. In the following description, all the functions of the control handle U will be described together, and for this purpose three main positions of the handle will be referred to, namely the positions for "recording" (I) and for "reproducing" (III) and the "intermediate" position (II), whereto the apparatus is set when the subscriber wishes to attend personally to incoming calls.

By means of the control handle U, the following groups are controlled:

(I) Switches in the exchange circuit, namely:

(*a*) Switch *u1* which in the "recording" position (I) (*a, b*) connects the device to the exchange line AB, and in the "intermediate" (II) as well as in the "reproducing" position (III) (*b, c*), connects the subscriber's station to the exchange line.

(*b*) Switches *u7*, *u8*, *u9* and *u10*, which for "recording" (I) (*a, b*) connect the input IT of the amplifier W to the exchange circuit and the amplifier output O to the recording device D and for "reproducing" (III) (*b, c*), connect the amplifier input IT to the pick-up and the amplifier output O to a loud-speaker T.—In the "intermediate" position (II) of the control handle, these switches may be set to one or to the other position.

(II) The switches in the circuits connected to the public supply line, namely:

(*a*) Referring to Fig. 1, for "recording" (I) the switches *u6*, *u2a, b, c* are closed and switches *u3* and *u4* are open; for "reproducing" (III) the switches *u6* and *u2a, b, c* are open and switches *u3* and *u4* are closed; in the "intermediate" (II) position of the control handle, switches *u3* and *u4* are open while switches *u6* and *u2a, b, c* may be open or closed.

(*b*) Referring to Fig. 7, for "recording" (I), switch *u2a* is closed and switch *u3a* is opened; for "reproducing" (III) switch *u2a* is open and

switch *u3a* is closed; in the "intermediate" position (II) of the control handle, switch *u3a* is open and switch *u2a* may be open or closed.

(III) The control shaft or shafts for coupling a single control shaft to the motor at different ratios and with different cams in their operative positions for "recording" (I) and "reproducing" (III), or alternatively for coupling a separate control shaft to the motor for "recording" (I) and for "reproducing" (III). In the "intermediate" (II) position of the control handle, the control shaft or shafts may be coupled to the motor in either position or may be disconnected therefrom.

(IV) Finally the counting mechanisms, which are influenced by the control handle U so as to vary their functions for counting the numbers of the recorded and of the reproduced calls. Moreover the readjusting of the pick-up needle to the beginning of the sound record not previously reproduced which must be effected between recording and reproducing, corresponds to a further function of the counting mechanisms. This last mentioned function is most advantageously coordinated to the "intermediate" position (II) of the general control handle U and in such a case, the control handle in the two embodiments above described, produces the following actuation of the counting mechanisms:

In the embodiment shown in Figs. 2, 3, 4 and 5, for "recording" (I) the disc **49** is shifted to the right so that the projection **51** thereon is engaged in a hole **53** in plate **52**; the lateral extension **40** on the toothed wheel **38** engages in the hole of the Geneva wheel **33** due to the bias of the spring **37**; the switch *u5* is set to its position *a*, *b*. In the "intermediate" position of the control handle U, the disc **49** occupies the same lateral position as it does with the control handle in its "recording" position (I); the lateral extension **40** on the toothed wheel **38** is withdrawn from the hole in the Geneva wheel **33**; switch *u5* may be set to either of its closed positions or it may be open. For "recording" (I) the disc **49** is shifted to the left so that the lateral projection **50** thereon engages in the hole of the wheel **47**; the lateral extension **40** on the toothed wheel **38** again engages the hole in the Geneva wheel **33**; the switch *u5* is set to its position *b*, *c*.

In the embodiment shown in Figs. 9 to 11, the control handle U has only to set the pawl *u12* into the positions as shown in Fig. 10*a* for "recording" (I), Fig. 10*b* for the "intermediate" position (II), and Fig. 10*c* for "reproducing" (III).

In this embodiment, after the apparatus has been set to the intermediate position (II), setting back to the "recording" position (I) before the calls already recorded have been reproduced, would have the effect that the new records would be recorded on the old sound tracks whereby both the old and the new records would be spoiled.

In order to prevent this, the control handle U may be arranged so as to be rotatable only in one direction, so that it can be moved from the intermediate position (II) into the "recording" position (I) only through the "reproducing" position (III).

In order to enable the subscriber to connect his station to the exchange lines (for example during a short visit) without being forced to reproduce all the recorded calls before setting-back the apparatus to "recording" position (I), a second intermediate position (II*a*) may be provided between the "recording" position (I) and the "intermediate" position (II) as mentioned before, in which new position only the switches in the exchange circuits and also, if desired, the switches in the circuits connected to the public supply mains, and the control shaft are set to the "intermediate" position (II) as mentioned before, the counting mechanisms remaining unaffected.

From this new intermediate position (II*a*) the apparatus may be arranged to be set back to the "recording" position (I) instead of forward to the "intermediate" position (II), so that the control handle has four positions, i. e. the two principal positions (I), (III) and two intermediate positions (II, II*a*) one only of which (the second intermediate position (II*a*)) is accessible from both adjacent positions (I) and (II).

The same effect may however be obtained with three positions only by retaining the second mentioned "intermediate" position (II*a*) and combining the first mentioned "intermediate" position (II) with the "reproducing" position (III). It is then necessary for the passing-over from the first "intermediate" position (II) to "reproducing" (III) to be effected automatically i. e. when the process of readjustment of the pick-up needle to the beginning of the sound record not previously reproduced, is completed. Time is also saved thereby since this readjustment takes place during the heating-up period of the amplifier valves.

Such an arrangement for the general control handle U has been described for example hereabove with reference to Figs. 9 to 11. The functions of the general control handle U in this embodiment are as follows:

The control handle U bears through a spring **106** on the armature of the electromagnet **165**, when the handle is set from the "intermediate" position (II*a*) to the "reproducing" position (III) and when the control handle is set back from the "reproducing" position (III) to the "intermediate" position (II*a*), the armature is lifted by the same spring.

In the "recording" position (I), the handle U and consequently the armature and pawl *u12* of the electromagnet **165** is also in the position shown in Fig. 10*a*. In the "intermediate" position (II*a*) of the handle, the armature of electromagnet **165** remains in the position shown in Fig. 10*a*, which is different from the arrangement described above.

In the "reproducing" position (III) the armature of electromagnet **165** is pressed downwards by means of the control handle U and the spring, first into the position shown in Fig. 10*b*, where it is stopped by an abutment **107** which forms the armature of an electromagnet **108** from which it is held away by a spring **109**.

The pawl *u12* must remain in this position during the whole of the readjustment of the pick-up needle to the beginning of the sound record not previously reproduced. At the end of this adjustment, the electromagnet is energised by closing switch **100** (Figs. 10 and 11). The circuit comprising the electromagnet **108** and the switch **100** shunts the electromagnet **165**, the magnetic hammer break **102**, **103** with switch **104** and the switch **157**. By energising the electromagnet **108** its armature **107** is withdrawn from below the armature of electromagnet **165** and the pawl *u12* connected thereto engages the ratchet wheels **170** and **149**, and simultaneously sets the switch *u11* to *a*, *b* (Fig. 10*c*), so that the circuit of the magnet **108** is interrupted. As the armature of the electromagnet **165** is now brought

into the same plane as the armature of electromagnet 108, the latter cannot return to its initial position although electromagnet 108 is not energised, as long as the pawl *u12* is in the "reproducing" position (III) (Fig. 10c).

As switch 100 must be closed when switch 157 is open, one contact of switch 100 must be connected to the ratchet wheel 170 and the other to the ratchet wheel 149 (Fig. 10).

When a circuit according to the diagram in Fig. 7 is combined with the mechanism as described hereabove with reference to Figs. 9 to 11, the switch *u3a* may be dispensed with, as switch *c6a* is closed automatically by the first step of the cam 136 during the readjustment and is open again when reproduction is completed, remaining open during the whole "recording" phase (III) as above described.

The readjustment of the pick-up needle to the beginning of the sound record not yet reproduced is made during the heating-up of the amplifier as described above. When the amplifier valves are still hot from an immediately preceding recording, this preheating time may be too short for the readjustment to be completed. In order to prevent the motor M from being started too early, a switch (not shown) is arranged in series with switch *za1* in the motor circuit only, which switch is closed only when the pawl *u12* is in its position for "reproducing" (III) (Fig. 10c).

In order to prevent the control handle U from being set to another position during "recording" (I) or "reproducing" (III) i. e. during the time when the amplifier circuit is closed, an electromagnet (not shown) is arranged in this circuit or parallel thereto, and serves when energised to lock the control handle U in its actual position.

Embodiments have been described above in which the recording stylus and the pick-up needle for reproducing are combined in a single acoustic device so that they may operate alternatively either by shifting the acoustic device D or the roller 21 (Fig. 6) by setting the general control handle U from its "recording" position (I) to its "reproducing" position (III) and vice versa.

Different acoustic devices may, however, be used for recording and picking-up which are preferably operative by shifting the roller 21. In such embodiments the recording stylus or other device is moved one step after each recording of a message and remains at rest during "reproduction" (III) whereas the pick-up needle is moved to the next track only after a message has been reproduced.

Therefore readjustment to the beginning of the record not yet reproduced is dispensed with. Switching-off after reproduction is effected when the pick-up needle reaches the part of the second record medium where the recording stylus is positioned for recording the next call.

Accordingly, each of the two acoustic devices are associated with a counting mechanism which may be used to switch off the apparatus when both mechanisms have counted the same number of calls.

Similarly to the embodiment shown in Figs. 9 to 11 two ratchet wheels 169 and 170 may be arranged each connected with a separate cam, these cams being of identical form. The pawl *u12* of electromagnet 165 is adjusted by the control handle U so as to act during recording on the wheel 169, and during reproducing on the wheel 170.

Switch *c6* is arranged so as to be open when the ratchet wheels are again in their initial position with respect to one another.

In apparatus using a single record medium, when it is desired to replace the medium, the recording device and the pick-up needle must be re-positioned to the side of the new medium where the first record track is to be made. This repositioning may be effected by setting the general control handle U to a new position (IV), which, however, is arranged so as not to be occupied by the handle U whilst being set from "recording" (I) to "reproduction" (III) or vice versa. A separate "record medium exchanging" key may be arranged for this.

When the apparatus is set to this "record medium exchanging" position (IV), switch *u11* is set to *b*, *c* and simultaneously the pawl *u12* actuated by the electromagnet 165 is displaced so as to engage both ratchet wheels 169 and 170 simultaneously.

A separate electromagnet may be arranged in such a manner that the electromagnet 165 is in the branch for recording and reproducing only and the other electromagnet is connected in parallel thereto in the branch for readjusting only. The armature of the magnet 165 is then adjustable by the control handle U, so as alternatively to engage the ratchet wheels 169 and 170, whereas the pawl of the second electromagnet is permanently associated with two ratchet wheels (not shown). One of these ratchet wheels is connected to the ratchet wheel 169 and the other to the ratchet wheel 170 and both are toothed for rotation in the reverse direction to wheels 169 and 170. When therefore the apparatus is set to the "record medium changing" (IV) position, the magnetic hammer break 103, 104 gives as many impulses either to one or the other electromagnet as is necessary for readjusting the ratchet wheels 169 and 170 to their initial positions, switch 157 being arranged to be opened in this position and to serve as a fixed starting point corresponding to the abutment 57 in Fig. 2. Switch *c7* is opened by an extension on the ratchet wheel 169 when the capacity of the sound record medium has been exhausted.

When two record media are employed, re-adjusting of the recording stylus to the initial position is not necessary so that the entire branch for effecting the readjustment (157, 102, 103, 104) is dispensed with and therefore switch *u11* is not necessary. Switches *c7* and *c7A* function as described with reference to Fig. 10.

Switch *cIIA* if provided, is arranged so as to be repeatedly closed by extensions on either cam, as each of the acoustic devices must pass separately from one medium to the other.

In apparatus in which the messages are recorded in parallel tracks on a medium which may be regenerated, effacing of the records not further required may be effected in several different ways, of which the following are preferred:

(A) Effacing of each record immediately before recording again on the same portion of the recording medium.

(B) Effacing each record simultaneously with recording in the preceding track.

(C) Effacing each record during reproduction of the record in the succeeding track.

In the alternatives (A) and (B), the effacing current circuit is closed during actual recording whereas in the alternative (C) it is closed during actual reproduction.

In the alternatives (B) and (C), a second ratchet wheel and cam is provided for the effac-

ing magnet which precedes or follows respectively that of the recording and pickup magnet by one step.

Furthermore, in the alternative (A), switch *c7* is not fixed and arranged to be opened by an extension 105, but is arranged like switch 157 between ratchet wheels 170 and 149 so as to be opened when these two wheels are displaced with respect to one another as many steps as correspond to the total capacity of the sound record medium, whereas in the alternatives (B) and (C), this opening of the switch 157 is effected one step earlier.

We have described in detail some embodiments of our invention with the sound records arranged in parallel tracks side by side. Embodiments of the invention will now be described, in which messages are recorded in alignment on a record medium which can be regenerated.

In Fig. 12 the motor is referred to by M and a shaft geared thereto by reference 118. The auxiliary devices which are required during the "recording" phase (I) only and the control shaft 2 for these devices, are driven by shaft 118 through a coupling member 110.

A separate shaft for controlling the "reproducing" phase (III) is dispensed with and spools 111 and 112 for the record medium are alternatively coupled to the shaft 118 by means of coupling members 16, 20 and 14, 19. The record medium is wound onto the spools 111 and 112 as shown in the figure, so that the spools rotate in opposite directions during movement of the medium in either direction. The coupling members are shown diagrammatically as friction rollers 14 and 16 similar to those shown in Fig. 6, and the same reference numerals have been used for similar parts. Alternatively, however, coupling members of different types such as electromagnetic coupling members may be used.

By means of a coupling roller 213 on the shaft of the spool 111 a cam disc 113 is driven so as to rotate through one revolution when the length of recording medium corresponding to one message is either recorded, wound back or reproduced. This disc 113 is provided with two cams 114 and 115, which control switches *m*IIA and *m*221 respectively, so as to close them temporarily during passage of the respective cam. The disc 113 is laterally shiftable so as to render the cam 114 inoperative during reproducing, as will be explained hereinafter in greater detail. During this period switch *m*IIA must be closed. Switch *m*IIA may, however, be shunted by a switch (not shown) which is closed only during this period, and in such an arrangement shifting of the disc 113 may be dispensed with.

Referring now to the circuit diagram in Fig. 13, two branches of the public supply circuit are provided, one of which is used during actual recording and the other of which is used during actual reproducing and during winding back of the record medium.

In the circuit used during recording, are provided two switches *m1* and *h1* in parallel, switch *h1* being closed by a calling relay (corresponding to relay H in Fig. 7 or Fig. 1).

On closure of the switch *h1*, the motor M is started and after rotating through a predetermined number of revolutions, the motor closes switch *h1* by a cam on the control shaft 2, and keeps this switch closed until the end of the recording of the actual call.

In series with switches *m1* and *h1* is a switch *c7* which is normally closed and is opened by a counting mechanism CM1 or CM2 (Fig. 14) after calls have been recorded equal to the total capacity of the record carrier.

In the circuit branch used during reproducing and winding-back of the record medium, are provided two pairs of switches *u3*, *c6* and *u13*, *c8*. One of the switches of each pair (*u3*, *u13*) is controlled by the general control handle U, the other one (*c6*, *c8*) is normally closed and is opened by counting mechanism CM1, CM3, respectively (Fig. 14).

While in the embodiments having parallel tracks, winding back must be effected after recording and reproduction of each individual call, forming subperiods of the main periods of actual recording (1) or reproducing (3) during which the acoustic devices are moved laterally to the next track, or the mesage prepared by the called subscriber for the calling subscriber may be reproduced, in the embodiment of the invention in which messages are recorded in alignment, readjustment both preparatory to reproduction (3*b*) and preparatory to further recording (I) after reproduction, is made in continuous but separate stages constituting separate periods.

The winding-back (4) of all reproduced calls preparatory to the recording of new calls, corresponds also to the readjustment of the pick-up to the starting point on the first track of a new record medium, when the record medium is exchanged (IV). But whereas this is not included in a normal working period, the corresponding winding-back in apparatus in which the messages are recorded in alignment on a regenerative record medium, forms a normal working period (4) which is coordinated with the other working periods in the same manner as the period of actual recording (1) or of actual reproducing (3).

In this embodiment there are accordingly four different working periods of the apparatus as shown diagrammatically in Figs. 19*a* and 19*b*.

These are,

Actual "recording" (1),

"Winding-back" the record carrier preparative to "reproducing" (3*b*),

Actual "reproducing" (3), and

"Winding-back" preparative to "recording" (4).

Four working positions of the general control handle U would accordingly be needed, to which an "intermediate" position (II) must be added. As explained with reference to the other embodiments, a sixth period would also be necessary, providing a "rest" period (6) for the apparatus between the periods for reproducing and recording. The total number of handle positions would thus amount to six, as compared with the other embodiments in which only four positions are provided. Similarly as in the other embodiments two working periods (3*b*, 3) of the apparatus are combined in the "reproducing" position (III) of the control handle. In this embodiment, each winding-back period (4, 3*b*, respectively) may be combined with its respective succeeding period (1, 3, respectively), and the rest period (6) between the reproducing (3) and recording (*i*) periods may be combined with the reproducing period (3) so as to limit the number of positions of the general control handle U to three as in the other embodiments (Fig. 19*a*).

However, by a slight modification, both winding-back periods (3*b* and 4) can be combined with the actual reproducing period (3) to a "reproduction" phase (III), thereby also obtaining

only three positions for the control handle U (Fig. 19b).

In Figs. 19a and 19b U indicates that the changes necessary in order to pass from one phase to the next one are made manually by means of the general control handle U, whereas references CM1, CM2, CM3 indicate that the changes at the ends of the respective periods are effected automatically by the respective counting mechanisms.

These counting mechanisms CM1, CM2, and CM3 are shown diagrammatically in Fig. 14. They are all shunted with respect to one another and controlled by the common switch *m*IIA and individually controlled by the manually operated switches *u*14, *u*15, *u*16, respectively, each of which is in series with another switch *uc*17, *c*9, *c*10, respectively, the function of which will be described later.

Each of the counting mechanisms CM1, CM2, CM3 consists of a pair of electromagnets which correspond in function to the electromagnets 65, 66 of the embodiment represented in Fig. 5 and which have been accordingly denoted 165_1, 166_1, 165_2, 166_2 and 165_3, 166_3, respectively.

The electromagnets of the counting mechanisms CM1 and CM3 are connected to the common switch *m*IIA each by a pair of switches connected together on one side. One switch of each pair (*u*230, *u*233 and *u*240, *u*243, respectively) is manually controlled by the general control handle U while the other ones (231, 242 and 232, 241, respectively) are manually controlled by the keys ⑭, ⑯, connecting the coupling members 14 and 16, respectively.

In Figs. 15 and 15a which correspond to the system represented in Fig. 19a, the circuit diagrams and the mechanical arrangements respectively of several electromagnets MG1, MG3, MG2, MG4 and MG5 are shown diagrammatically, each of which corresponds in design and in function to that of electromagnet MG and armature 88 in Fig. 8. Electromagnets MG2 and MG4 are however each equipped with a second armature and the second armature of electromagnet MG2, indicated in Fig. 15 in double lines, does not serve as a locking means but to move the switches *m*IIA, *c*9 and *c*10 (Fig. 14) out of their normal positions so as to be locked in and released by other elements such as the armature of electromagnet MG4 and the general control handle U as will be described in greater detail hereinafter.

The electromagnets MG1 and MG3 cooperate with the counting mechanism CM1 and are controlled by the individual switches 228 and 229, respectively, and by the common switches *m*221 and *c*237 connected together on one side and in series with both of the electromagnets MG1, MG3.—Electromagnet MG2 cooperates with the counting mechanism CM2 and is controlled by the switches 234 and *c*222 connected in series.—Electromagnets MG4 and MG5 cooperate with the counting mechanism GM3 and are controlled by the individual switches 235 and 236, respectively, and by the common switch *c*223 connected in series with both switches 235 and 236.

The switches 228, 229, 234, 235 and 236 are locked in their closed positions by the armatures of the electromagnets MG1, MG3, MG4 and MG5, respectively, concurrently with the coupling members 16, 14 and 110 being locked by these armatures, and are released so as to return to their normal open positions, as soon as the appropriate electromagnet has been energised for release of its respective coupling member.

As will be described later in greater detail, the switch *uc*17, which is normally closed, is to be set to its open position by the general control handle U so as to be locked in its open position by the armatures of the electromagnets MG2 or MG4, respectively. In order to open the switch *uc*17 when locked by either of the armatures of electromagnets MG2 or MG4, a fixed common contact is arranged to contact with two separate contacts in series in the circuit as shown in Fig. 15a, which contacts are secured respectively on the levers locked by said armature so that the circuit is broken when either of the two levers is locked by its respective armature during the winding back periods 4 and 3b, respectively.

The function of the counting mechanisms and associated electromagnets will be clear from the following description.

When in an apparatus functioning according to the system represented in Fig. 19a, the general control handle U is set to "recording," the record medium must first be spooled back (first period (4) of the "recording" phase (I)), provided of course that at least one call has been reproduced in the foregoing "reproducing" phase (III). For this first period (4) all connections may be left in the positions in which they were during the "reproducing" phase (III) and some of the connections such as switch *u*1 and coupling member 110 are even locked in these positions by the armature of electromagnet MG5 (Figs. 15 and 15a), as will be described later in greater detail. Switch *uc*17 must be opened by setting the general control handle U to "recording" position (I) in order to prevent counting mechanism CM1 from operating during the first period (4), the key ⑭ and the switch *m*IIA are released from their positions in which they have been locked during the foregoing reproduction period (III), as will be described in greater detail hereinafter, switches *u*14 and *u*15 are set to *a*, *b*, switch *u*16 is set to *b*, *c* (Fig. 14), switch *u*13 (Fig. 13) is closed and coupling member 14 (Fig. 12) is connected.

The switch *uc*17 and the coupling member 14 are, by setting the general control handle U to "recording" position, locked in their open and connected positions, respectively, by engaging them in the armature of the electromagnet MG4 (Figs. 15 and 15a) in a similar manner to the locking of the armature 88 of the electromagnet MG under the end of lever 85 in the mechanism represented in Fig. 8. Switch 235 is also locked in its closed position in the armature of the electromagnet MG4.

As counting mechanism CM3 is out of its initial position after reproduction of at least one call (Fig. 20), switch *c*8 (Fig. 13), which is controlled thereby in a manner similar to the control of switch *c*6 by the groove 75 in the mechanism shown in Fig. 5, will be closed. Accordingly the motor M is started and the record medium is wound back onto reel 112.

By this spooling back (4) impulses are sent from *m*IIA to magnet 166_3 and the counting mechanism CM3 is restored to its initial position (Fig. 20), whereupon it opens switch *c*8 and releases the coupling member 14 from its locked connected position by closing the switch *c*223 (Figs. 15 and 15a) whereby electromagnet MG4 is energised and attracts its armatures, one armature releasing the switches 235 and *uc*17 whereby they return to their normal open and closed positions, respectively, and the other armature releasing switches *c*9, *c*10 locked therein. The

first period (4) of the "recording" phase (I) is thereby terminated.

Moreover as the counting mechanism CM3 in this position closes switch c223 (Fig. 15) and switch 236 is locked in its closed position at that time as will be described in greater detail hereinafter the electromagnet MG5 is thus energised (Figs. 15 and 15a), effecting the following changes:

Coupling member 110 (Fig. 12) and switch u1 (Fig. 7 or Fig. 1), which have been set to their disconnected and "b c" positions, respectively, by setting the general control handle U to its intermediate position where they are to remain during the "reproduction" phase (III), and where they are locked upon setting the general control handle U to its "recording" position by engaging them in the armature of electromagnet MG5 as will be described in greater detail in connection with these positions (II and III) are released to return to their connected and "a, b" positions, respectively, so as to connect the control shaft 2 (Fig. 12) to the motor M and to switch off the subscriber's station Y and to switch in the apparatus, and to connect all the switches of the acoustic system (Fig. 1) for recording, respectively.

Prior to recording a new series of messages, the old records must be effaced. This may be done during the first period (4) of the "recording" phase (I) by closing the circuit of the effacing magnet (not shown) when setting the general control handle U to "recording." The switch of the effacing circuit (not shown) in this case is locked in its closed position in one armature of the electromagnet MG4 and released by the counting mechanism CM3 at the end of said period (4), simultaneously with switch uc17 and coupling member 14. Effacing may also be effected, however during the second period (i) of the "recording" phase (I) at a point which is passed by the record medium before it reaches the recording means.

When the current for the effacing magnet circuit is derived from the amplifier W, the motor M must not be started before the amplifier valves are heated up, and this may be ensured by arranging a pair of switches u2a and z1 as in Fig. 7, with the difference that switch u2a is opened by the general control handle U when set to "recording" and locked in one armature of the electromagnet MG4, and is released so as to return to its closed position by the counting mechanism CM3 at the end of the first period (4) of "recording" phase (I) as described with reference to switches uc17, 235 and the switch of the effacing current.

The apparatus is now ready for recording (i) of the incoming calls. Switch c7 (Fig. 7) being in its normal closed position, the motor M is started as soon as switch h1 is closed by the calling relay H (Fig. 7 or Fig. 1). After a certain number of revolutions of the motor M, which in view of the coupling member 110 being connected as mentioned hereabove, now drives shaft 2, the coupling member 16 is moved into its engaging position due to a cam 202 (Figs. 12 and 15a) arranged on shaft 2, whereby the record medium is wound onto reel 111 (Figs. 12 and 12a). If effacing has not already been effected during the first period (4) of the "recording" phase (I), the effacing current circuit is now closed by a cam on the control shaft 2.

Coupling member 16 is locked in its connected position by engaging it in the armature of electromagnet MG1 (Fig. 15) and at the same time, the normally open switch 228 is locked in its closed position. As soon as the coupling member 16 is connected, the disc 113 (Fig. 12) is rotated by the motor M through the coupling roller 213 and after completion of one revolution closes switch m221, whereby electromagnet MG1 (Fig. 15) is energised and releases both the coupling member 16 and the switch 228 so as to allow them to return in their disconnected and open positions, respectively. This process is repeated every time that a new incoming call is recorded. Disc 113 thus acts as a means for metering the length of each call which in the present embodiment is not longer than a certain predetermined length.

Now the disc 113 is rotated by the coupling roller 213 in the reverse direction when being driven from the motor shaft 118 by the coupling mechanism 16, 20 to its direction of rotation when driven indirectly by the coupling member 14, 19, reel 112, record medium and reel 111 (Figs. 12 and 12a). Consequently when recording the first incoming call, rotation of disc 113 is reversed after the spooling back (4) preparatory to recording (i) and cam 115 would release the coupling 16 immediately after it had been engaged. In order to avoid this, the cam 202 on shaft 2 is shaped so as to keep the coupling member 16 in its connected position until after the production of the first impulse produced in electromagnet MG1 by the cam disc 113 so that this impulse passes without effect.

Disc 113 being equipped in addition to cam 115 for the control of switch m221, with another cam 114 for the control of switch mIIA (Fig. 12), the counting mechanism CM1 counts the incoming calls during the second period (i) of the "recording" phase (I); switch u14 being still at a, b, switch uc17 having returned to its closed position at the end of the first period (4), of the "recording" phase (I), and switch u230 being in its normal closed position, the electromagnet 165_1 (Fig. 14) is energised each time the switch mIIA is closed by cam 114 and the counting mechanism CM1 is moved forward one step.

The counting mechanism CM2 is also moved forward one step (compare also Fig. 20) for each incoming call as switch u15 is still at a, b and switch c9 is in its normal closed position so that electromagnet 165_2 is energised each time switch mIIA is closed by cam 114.

The counting mechanism CM3 is inoperative during this second period (i) of the "recording" phase (I) as switch c10 is in its normal open position.

If after using up the capacity of the record medium a new call arrives, the apparatus must be prevented from operating. This is ensured since counting mechanism CM2 which has counted the number of incoming calls has reached its end position, in which switch c7 (Fig. 13) is opened by a feeler such as 76 engaging a groove such as 75 of the mechanism represented in Fig. 5, so that the motor M does not start upon closing of the switch h1 by the calling relay H.

It will be noted that said end position of the counting mechanism CM2 is however not identical with its initial position when the apparatus is ready to record a first incoming call in which switch c7 is in its normal closed position and the motor may be started.

As described hereabove, the cam 115 on the disc 113 closes switch m221 immediately after the disc reverses its sense of rotation at the

beginning of the second period (1) of the "recording" phase (I), the first impulse thus produced being rendered ineffective on coupling member 16 by appropriate shaping of the cam 202 on shaft 2. Both counting mechanisms CM1 and CM2, however, have already been moved one step by this first impulse and accordingly at the end of the last recorded call, have counted a number exceeding that of the incoming calls by one. It will be seen subsequently that this fact is advantageous in the "reproducing" phase (III), as is described later.

When now the general control handle U is set to the "intermediate" position (II), the subscriber's station Y is switched in by switch *u*1 (Fig. 7 or Fig. 1), being set to *b*, *c* where it is held by the general control handle U during the subsequent "reproducing" period (III). Preferably all the acoustic circuits (Fig. 1) are already connected for reproducing. As mentioned above, all these electrical and mechanical conditions are to be reset to their recording positions automatically by the counting mechanism CM3 after termination of the first period (4) of the "recording" phase (I), and not by setting the general control handle U from the "reproducing" position (III) to the "recording" position (I). In order to enable the apparatus to be set back from the "intermedate" position (II) to the "recording" position (I) the coupling member 110 and these connections must not be locked in their disconnected and reproducing positions respectively when setting the general control handle U to the "intermediate" position (II), but they may be locked either on setting the control handle U to the "reproducing" position (III) from the intermediate position (II) or on setting it to the "recording" position (I) from the "reproducing" position (III) as briefly mentioned hereinbefore with reference to the setting of the general control handle to its "recording" position (I).

Whilst the control handle U is in the "intermediate" position (II), all other connections remain the same as they were during the "recording" phase (I). It is, however, advisable to disconnect the coupling member 110 (Fig. 12) by setting the general control handle U to the "intermediate" position (II). However, by setting the control handle U to its "recording" position (I), this coupling member is locked in its disconnected position by the armature of the electromagnet MG5, simultaneously locking the switch 236 in its closed position by said armature wherefrom it is released by counting mechanism GM3 closing switch *c*223 at the end of the first period (4) of the "recording" phase (I) as briefly mentioned already hereabove.

Switches *u*14, *u*15, *u*16 may be in either position during the "intermediate" position of the general control handle U and all of the counting mechanisms CM1, CM2, CM3 are at rest in this position (Fig. 20).

When set to its "reproducing" position (III), the general control handle U sets switches *u*14 and *u*16 to *a*, *b*, *c* and switch *u*15 to *b*, *c*, opens the switches *u*230, *u*233, *u*240 and *u*243, opens switch *uc*17 and locks it in its open position under the control of one armature of electromagnet MG2 (Figs. 15 and 15*a*), and closes switch *u*3 (Fig. 13), whereby the motor M is started provided the switch *c*6 is also closed. This occurs when at least one call has been recorded, the counting mechanism CM1 being then out of its initial position (compare Fig. 5). At the same time the coupling member 14 is connected and locked in its connected position by one armature of electromagnet MG2 (Figs. 15 and 15*a*) where switch 234 is simultaneously locked in its closed position. With the motor M running and the coupling member 14 connected, the recording medium is wound back onto reel 112 during this first period (3*b*) of the "reproducing" phase (III).

During this period counting mechanism CM1 is inoperative, switch *uc*17 being opened by setting the general control handle U to its "reproducing" position.

Counting mechanism CM2, however, counts backward during this period (3*b*), switch *c*9 being in its normal closed position and switch *u*15 being set to *b*, *c* by the general control handle U (Fig. 14). So each time the switch *m*IIA is closed by the cam disc 113 completing one revolution (corresponding to one call being wound back) electromagnet 166_2 is energised. When all the recorded calls have been wound back, the counting mechanism CM2 returns to its initial position (Fig. 20) thereby closing switch *c*222 (Fig. 15).

As soon as switch *c*222 is closed, the electromagnet MG2 is energised and releases switches *uc*17 and 234 and coupling member 14, which have been locked by one of its armatures. Thereby counting mechanism CM1 is switched in preparatory to the second period (3) of the "reproducing" phase (III), the spooling back of the record medium on reel 112 is terminated and electromagnet MG2 is de-energised.

This electromagnet MG2, however, as already mentioned, has a second armature which, when attracted by the electromagnet MG2 shifts the cam disc 113 to a position where it is locked against being shifted back and maintains switch *m*IIA closed. At the same time switch *c*9 is opened and switch *c*10 is closed by said second armature of electromagnet MG2 and both these switches are locked in their new positions by the second armature of the electromagnet MG4 (Figs. 15 and 15*a*).

By opening switch *c*9, counting mechanism CM2 becomes inoperative in the subsequent second period (3) of the "reproducing" phase (III) while counting mechanism CM3 which was inoperative during the first period (3*b*) with switch *c*10 open now becomes operative for the second period (3) by closing switch *c*10 as described hereabove.

In this second period (3) of the "reproduction" phase (III), actual reproduction of the individual calls is effected by depressing the reproduction key and thereby connecting coupling member 16 and locking it in its coupling position, in the armature of electromagnet MG1 (Fig. 15). Simultaneously switch 228 is closed and locked in its closed position, in the armature of electromagnet MG1.

As the motor keeps rotating from the beginning of the "reproducing" phase (III), the record medium is now wound on reel 111, passing the pick-up (not shown in Fig. 12) for reproduction (3) until disc 113 has completed one revolution and by means of cam 115 closes switch *m*221 and thus energises electromagnet MG1 (Fig. 15), whereby the coupling member 16 and the switch 228 are released so as to return to their disconnected and open positions, respectively.

The motor M still keeps rotating and by again depressing the reproduction key ⑯ the next call

is reproduced in the same way as described above.

As switch *m*IIA has been locked in its closed position at the end of the first period (*3b*) of the "reproducing" phase, in the second period (**3**), the counting mechanism CM**1** and CM**3** are not moved when the disc **113** completes one revolution, but switches **232** and **241**, respectively, are closed any time that the key ⑯ is depressed for connecting the coupling member **16** (Fig. 14). Accordingly, electromagnets **166** and **165**, respectively, are energised and the counting mechanisms CM**1** and CM**3** are moved one step backward and one step forward, respectively, (Fig. 20).—Counting mechanism CM**2** is inoperative in this period (**3**) as already stated hereabove.

For repetition of the reproduction of a call, the record medium must first be wound back a length corresponding to that of the call to be repeated. This is effected by depressing the other key ⑭ which connects coupling member **14** and locks it in its connected position by the armature of the electromagnet MG**3** (Fig. 15), whereby simultaneously switch **229** is also locked in its closed position. When the length of the call has been wound back on reel **112**, disc **113** has again completed one revolution, and closing the switch *m***221** energises electromagnet MG**3**, thus releasing the coupling member **14** and the switch **229** to return to their disconnected and open positions, respectively.

On depressing the repetition key, the switches **231** and **242** of counting mechanisms CM**1** and CM**3**, respectively, are closed (Fig. 14), thus energising the electromagnets 166_1 and 166_3, respectively, and causing counting mechanism CM**1** to move forward one step and counting mechanism CM**3** to move backward one step for each winding back preparatory to a repetition (Fig. 20).

It will now be clear why it is advantageous for the counting mechanism CM**1** to count during recording (**1**), a number exceeding that of the calls recorded by one: As switch **232** is temporarily closed by the key ⑯ of coupling member **16** at the beginning of the reproduction (**3**) of a call, the counting mechanism CM**1** has counted as many calls as have been recorded when the reproduction of the last recorded call has been started. When after reproduction of this last call the reproduction key ⑯ is again depressed, the counting mechanism CM**1** is again moved one step so as again to exceed the number of the calls by one. Accordingly, the counting mechanism CM**1** is brought back to its initial position and opens switch *c***6** (Fig. 13 and Fig. 5), thereby cutting out the motor circuit.

As the motor circuit is interrupted by switch *c***6** when the key ⑯ for operating coupling member **16** is depressed after the last call has been reproduced, the coupling member **16** remains connected and means are provided to disconnect it again; a second switch *c***237** is connected in parallel with switch *m***221** (Fig. 15), which is closed by the counting mechanism CM**1** when it is in its initial position.

As switch **228** is closed when the coupling member **16** is connected, electromagnet MG**1** is energised upon closing of switch *c***237**, whereby coupling member **16** is released and switch **228** reopened.

As soon as the first call is recorded in the next "recording" phase (I), switch *c***237** is reopened by counting mechanism CM**1** leaving its initial position (Fig. 20).

As mentioned hereabove, the switches *c***9**, *c***10**, respectively, have been locked by the second armature of the electromagnet MG**2** by engaging it in the second armature of electromagnet MG**4** (Fig. 15). When at the end of the first period (**4**) of the "recording" phase (I) counting mechanism CM**3** has returned to its initial position (Fig. 20) and has closed switch *c***223**, electromagnet MG**4** is energised and by attracting its second armature releases the switches *c***9**, *c***10**, as already briefly mentioned above.

As already described in connection with the cam **202** on shaft **2**, the coupling member **16** would be disengaged immediately after having been connected when disc **113** reverses its sense of rotation after winding back (**4**) preparatively to recording (**1**). The same applies to coupling member **16** when the reproduction key ⑯ is depressed for the reproduction of the first call or for the repeated reproduction of a call, and to coupling member **14**, when the repetition key ⑭ is depressed for winding back preparatory to the repetition of the reproduction of a call. Accordingly these keys ⑯, ⑭ are constructed so that not only do they lock the coupling members **16** and **14**, but also maintain them coned so that not only do they lock the coupling members **16** and **14**, but also maintain them connected as long as necessary for the first impulse of disc **113** to pass ineffectively. This may be obtained by means of mechanism similar to that of the button **63** in Fig. 2.

When the key ⑭ operating the coupling member **14** is depressed after the last recorded call has been reproduced, it does not return to its initial position because switch *c***6** has opened the motor circuit and consequently the mechanism similar to that operated by the button **63** in Fig. 2 has come to rest before having released the key. As with this key ⑭ locked, the switch **232** (Fig. 14) remains closed, a current would flow for a considerable time through the coil of electromagnet 166_1, and to avoid this, the switch **232** is constructed so as to be closed only temporarily when the key ⑭ is actually depressed, and not when it is released. As already described above briefly, the key ⑭ of switch **232** is released by the control handle U when set to its "recording" position (I) and this is performed for example by withdrawing a member corresponding to member **42** in the arrangement shown in Fig. 2.

As both coupling members **16** and **14** must not be connected at the same time, the key ⑯ connecting the member **16** is locked when the member **14** is connected and vice versa. Simultaneously with this locking, a visual signal may be given to the subscriber. The key ⑭ connecting the member **14** must be further locked when the reel **111** is empty, and this may be effected by means of a feeler or the like which is pressed on to the drum of the reel **111** by the recording medium against the bias of a spring.

As mentioned hereabove, switch *m*IIa has been locked in its closed position by means of the second armature of the electromagnet MG**2** at the end of the first period (*3b*) of the "reproducing" phase (III) in order to effect the control of the counting mechanisms CM**1** and CM**3** by the reproduction key and the repetition key during the second period (**3**) of said phase (III). As for winding back (**4**) the record medium preparatory to recording (**1**), counting mechanism CM**3** must again work automatically and switch *m*IIA must be released prior to the begin-

ning of the first period (4) of the "recording" phase (I). This may be effected in the embodiment corresponding to Fig. 19*a*, for example, by setting the general control handle U to "recording" position (I).

Having described an embodiment of the apparatus in which winding back (4) preparative to recording is combined with actual recording (1) in the "recording" phase (I) and winding back (3*b*) preparative to reproducing is combined with actual reproducing (3) in the "reproducing" phase (III), an embodiment will now be described in which both winding back periods (4, 3*b*) are united with the actual reproducing (3) to form a "reproducing" phase (III) having three periods (as shown in Fig. 19*b*).

The circuit diagrams of the electromagnets of this embodiment have been represented in Fig. 16. The modifications involved in the circuit diagrams of Figs. 13 and 14 as compared to the embodiment following the system of Fig. 19*a* have been indicated by dotted lines and by bracketing references to elements or periods by or during which switches are opened or closed, when such elements or periods differ from those shown in Figs. 13 and 14. Likewise in Fig. 20 the interchanged positions of the periods 4 and 6 are indicated by bracketed numerals, the altered operations of the counting mechanism CM3 being shown in chain dotted lines.

When setting the general control handle U in the new embodiment to its "recording" position (I), all those changes of connections are established which in the embodiment according to Fig. 19*a* have been automatically made by the counting mechanism CM3 at the end of the spooling back of the recording medium preparative to recording (1) as described hereabove.

All mechanical and electrical elements, however, which heretofore have been locked in their "reproducing" position by the general control handle U when being set to its "recording" position (I), or to its "reproducing" position (III), so as to be released to pass into their "recording" positions by the counting mechanism CM3, are now controlled by the control handle U alone and it is thus now not necessary to lock these elements. It is also not now necessary to lock the coupling member 110 in its disconnected position as it is now under control of the general control handle U only, or to lock the connections which are changed when connecting or disconnecting this coupling member. The electromagnet MG5 (Figs. 15 and 15*a*) and the corresponding switch 236 (Fig. 16) are therefore dispensed with. Switch *c*9 of counting mechanism CM2 may be now normally open and be closed by the general control handle U when set to its "recording" position (I).

As in this embodiment winding back (4) of the record medium preparative to recording (I) has already been effected during the last period of the preceding "reproducing" phase (II), the apparatus is now ready immediately to receive messages when the general control handle U is set to its "recording" position (I), the period (1) of the "recording" phase which was previously the second period, having become now the only period of the "recording" phase.

When now a call is made, the counting mechanisms CM1 and CM2 (Fig. 14) and the mechanism represented in Fig. 12 function in exactly the same manner as is described above.

Also the intermediate position (II) in this embodiment serves the same purpose as in the foregoing embodiment.

When the apparatus is now set by the general control handle U to "reproduction" (III), winding back (3*b*) of the recording medium is effected and switches *u*230, *u*233[1] are opened the same way as in the foregoing embodiment, so that, as before, the counting mechanism CM1 is inoperative during this period (3*b*).

The counting mechanism CM2 may be controlled in the same manner as before, or switch *c*9 thereof may be normally open (as indicated in dotted lines in Fig. 14) and be closed by the coupling member 14 during the said period (3*b*). This counting mechanism CM2 as before, counts back during the winding back (3*b*) of the recording medium preparative to actual reproduction and terminates this period as soon as it has reached its initial position by closing switch *c*222 (Fig. 16) and, switch 234 being locked in its closed position for winding back of the recording medium, electromagnet MG2 is energised and thereby releases coupling member 14 and switch 234 so that they return to their disconnected and open positions respectively, as with the embodiment previously described.

The apparatus is now ready for actual reproducing (3) which is effected by depressing the key ⑯ for the coupling member 16 in the same way as described with reference to the previous embodiment. This applies also to repetition which is effected by depressing the key ⑭ of coupling member 14.

After reproduction of the last recorded message, winding back (4) of the recording medium is automatically initiated by counting mechanism CM1 returning to its initial position. As the motor which has been running since the beginning of the "reproduction" phase (III) must now continue running after terminating the period (3) of actual reducing, for winding back (4) the recording medium, the counting mechanism CM1 does not now open switch *c*6 (Fig. 13) but instead closes switch *c*239 of an electromagnet MG6 (Fig. 16) an armature of which connects the coupling member 14 and keeps it in its connected position during the winding back period (4) preparative to further recording.

This electromagnet MG6 replaces the electromagnets MG4 and MG5 of the embodiment shown in Figs. 15, 15*a* and 19*a*, these electromagnets together with their associated switches 235 and 236 and switch *c*10 being dispensed with. Electromagnet MG6 has also two armatures one of which serves to lock and to release the switch *m*IIA when in its connected position into which it has been brought by the second armature of electromagnet MG2 at the end of the winding back period (3*b*) preparative to actual recording (3), the same as in the previous embodiment. The second armature of electromagnet MG6 (shown in double lines) serves to connect the coupling member 14 and to close the switches *u*240 and *u*243 of counting mechanism CM3 (Fig. 14) as long as electromagnet MG6 is energised but not to lock them beyond that time.

This condition ought to be established during the third period (4) of the "reproducing" phase (III) when the recording medium is wound back preparative to the "recording" phase (I). Therefore two switches *c*239 and *c*233 are arranged in series, one switch *c*239 being normally open and arranged to be closed by the counting mechanism CM1 when in its initial position after reproduction (3) of the last message, and the other switch

c223 being normally closed and arranged to be opened by the counting mechanism CM3 when returning to its initial position after having completely wound back (4) the recording medium.

Counting mechanism CM3 in this position also opens the switch c6 (Fig. 13) which in the previous embodiment had been controlled by counting mechanism CM1. The switches u13 and c8 may accordingly be dispensed with.

Switch uc17 may also be dispensed with since the second winding back period (4) is now included in the "reproducing" phase (III), during which all the switches u230, 231, 232 and U233 are open so that no electrical impulses due to the closing of the switch mIIA by the cam 114 on the disc 113, can pass through the coils of the electromagnets 165_1 or 165_2 of the counting mechanism CM1.

In the counting mechanism CM3, however, the switches u240 and u243 are now normally open (as shown in dotted lines in Fig. 14) and are closed by the second armature of the electromagnet MG6 (Fig. 16). Therefore switch c18 may also be dispensed with since the impulses caused by the cam 114 on disc 113 closing switch mIIA, energise the electromagnet 166_3 of counting mechanism CM3 only during the winding back period (4) preparative to the "recording" phase, when this counting mechanism counts back (as shown by the chain-dotted line in Fig. 20).

Switches uc17 and c18 being dispensed with, and the control of switch c9 being altered, the second armature (shown in double lines) of electromagnet MG2 is much simplified as compared with the embodiment shown in Figs. 15, 15a and 19a, and serves only to engage switch mIIA in the closed position wherefrom it is not now released by the general control handle U but by the first armature of electromagnet MG6 to which it has been accordingly locked by the second armature of electromagnet MG2.

Instead of closing switch mIIA and keeping it closed by locking the cam disc 113 in its shifted position, the switch mIIA may be shunted by a switch (not shown) which is closed and locked in its closed position by the second armature of electromagnet MG2 by engaging it in the first armature of electromagnet MG6 by the energising of which it is released or it may be shunted by two switches (not shown) one of which is closed by the counting mechanism CM2 in its initial position, and the other of which is opened by the counting mechanism CM1 in its initial position.

It will be noted that the electromagnet MG6 differs from the other ones in that no switch is provided in series with the electromagnet, which is locked in its first armature.

In both embodiments of the apparatus as above described, when the messages are recorded in alignment, it is advisable to arrange the general control handle U so as to be rotatable only in one direction from the "recording" (I) and from the "reproducing" (III) position. From the intermediate position (II), the control handle may be arranged for setting back to "recording" (I) position.

In the "recording" (I) and in the "reproducing" (III) positions, the control handle U is also prevented from being set to another position whilst the amplifier or the motor circuit is closed. To this purpose an electromagnet (not shown) is connected in the amplifier circuit or in parallel thereto, which electromagnet, when energised, locks the control handle in its actual position. At the same time a visual signal is given to the subscriber for example by connecting a small glow-lamp in parallel with the locking circuit.

The invention may also be applied to apparatus for automatically recording and reproducing messages the length of which is limited only by the capacity of the record medium.

In the following such an embodiment of the invention is described in which messages are recorded in alignment on a medium which may be re-generated.

For recording purposes, the switching in of such a device may be effected for example by a calling relay such as H (Fig. 7 or Fig. 1), or in any other suitable manner.

Switching off of the apparatus is under control of the calling party. For example, the switch m1 in the motor circuit shown in Fig. 13 may be kept closed only long enough after the cessation of the calling signal for the distant subscriber to receive the request to deliver his message and to begin to deliver it. Hereafter the motor circuit depends on a relay controlled by a relay responsive to the voice current and sluggish enough to remain energised during gaps between words and syllables.

As the messages to be recorded and reproduced are not of uniform length a metering device such as the disc 113 of the above-described embodiment is dispensed with. Consequently the counting mechanisms CM1, CM2, and CM3 of the foregoing embodiments which count the number of messages of uniform length are replaced by metering devices which perform a similar function, by metering the length of the recording medium used for recording the total length of all the individual messages, for regulating the amount of winding back of the recording medium and for regulating the length of recording medium used in reproducing all the messages recorded.

In the embodiment represented in Fig. 17 metering device MD1 corresponds in function essentially to the counting mechanisms CM1 of the foregoing embodiments. The function of counting mechanisms CM2 and CM3 is performed by a simple switch c222 arranged in the circuits of the electromagnets MG3a and MG5a by the armatures of which the coupling members 14 and 118, respectively, are locked together with the switches u234 and 236, respectively, the function of which latter will be explained hereafter in greater detail. Metering devices corresponding to the counting mechanisms CM2 and CM3 are accordingly dispensed with. A fourth metering device MD4 however is also necessary for measuring the length of each individual message.

In the embodiments now to be described, the period division of the phase is as shown in Fig. 19a. The description hereinabove, with reference to the embodiment of the apparatus in which the individual messages are of uniform length applies generally to this embodiment also. There are of course differences due to the fact that the individual record lengths of the messages in this embodiment are of different length. The most important is that in counting, the functions of the metering devices are now altered to meter the actual length of the recording medium used instead of simply counting the number of messages, as was done by the counting mechanisms CM1, CM2 and CM3 in the foregoing embodiment. To this purpose the metering devices incorporate electromagnetic clutches which are engaged dur-

ing the individual periods with the reels on which the recording medium is wound.

This is done in the following way: Metering device MD1 which measures forward the length of the messages during actual recording (1) and backward during actual reproducing (3) and forward again during winding back (3b) for repetition (3a), must either be coupled alternatively to the reels 111, 112, which rotate in opposite directions during recording (1) and reproducing (3) on the one hand, and during winding back (3b) on the other hand, or when the metering device MD1 is always coupled to the same reel, it must be connected thereto by a gear which appropriately reverses its direction of rotation. In any case, coupling may be effected by two electromagnetic clutches, the electromagnets of which are denoted 304 and 305, respectively, (Fig. 17).

Electromagnet 304 is arranged in series with two switches 244 and u245, switch 244 being closed while the coupling member 16 is in its engaging position while switch u245 is controlled by the general control handle U.

The electromagnet 305 has associated therewith three switches 246, 247 and u248 of which 246 and 247 are connected together at one side and each is in series with switch u248. Switch 246 is closed when coupling member 14 is connected by the key ⑭ only but not when it is connected by the general control handle U and switch 247 is closed when coupling member 16 is connected. Switch u248 is controlled by the general control handle U.

The metering device MD4 may consist for example of a tape of insulating material which is wound to-and-fro by a pair of reels (not shown) at a speed which is proportional to the speed of the recording medium. This tape is perforated by an electro-magnetically operated punch (not shown), the circuit for the magnet of which is closed by the relay for breaking the motor and amplifier circuits each time a message is terminated. Alternatively, perforations may be made each time a call signal arrives by energising said electromagnet, during the recording phase (I), by closing a switch operated by the calling relay H (Fig. 7 or Fig. 1), and moreover a final perforation is made on the temporary closing of a separate switch in parallel with that operated by relay H, by the control handle U when passing from the "recording" position (I) to the "intermediate" position (II).

An electric feeler of switch c221 (Fig. 18) may slide on the tape so as to make contact with a conductive support for said tape as soon as a perforation in the tape passes under said feeler, which may be arranged either in front of the perforating mechanism which is at the side of the reel of said tape which corresponds to reel 112 of the recording medium, or the feeler may be moved into its operative position by the general control handle U when set to "reproduction" (III) only.

As the said tape may be very thin and moved at a very low speed, it may serve for several series of reproductions, and it is not necessary to wind it back after one of said series has been completely reproduced so that its unperforated portion is available for the next series of messages to be recorded. The available space on the tape is preferably indicated to the subscriber in a suitable manner so as to provide a warning enabling the tape to be changed when necessary. However, if this warning should be overlooked, the apparatus will be disconnected from the energising circuit as soon as the tape is exhausted, for example by means of a normally closed spring-loaded switch (not shown) arranged on the drum of the tape on which the remaining unperforated portion of the tape is wound so as to be opened when the reel becomes empty.

The tape of metering device MD4 is accordingly wound in the same direction as the recording medium during actual recording (1) and winding back (3b) for reproducing, but may be at rest during winding back (4) for recording. The reels on which tape are wound are therefore detachably coupled to the reels 111, 112, on which the recording medium is wound by two electromagnetic clutches, the electromagnets 306 and 307 of which are connected as shown in Fig. 17.

One electromagnet 306 of the metering device MD4 is arranged in series with a switch 249 which is closed when the coupling member 16 is in its connecting position. The other electromagnet 307 is arranged in series with the two switches 250 and u251, of which switch 250 is closed when the coupling member 14 is engaged and switch u251 is controlled by the general control handle U.

As regards the motor and amplifier circuits for this embodiment, these are the same as shown in Fig. 13. The branch circuit containing the switches h1, m1, c7 must however be arranged in a different manner, but includes switch c7 which is opened by the metering device MD1 when the capacity of the recording medium becomes exhausted.

Switch c6 is again opened by the metering device MD1 when returning to its initial position after all the messages recorded have been reproduced. Means however must be provided for opening the switch c6 rapidly as this switch is somewhat heavily loaded.

A series of electromagnets MG1, MG3a and MG5a (Fig. 18), the function of which essentially corresponds to those shown in Figs. 15 and 16, are associated with the metering devices in this embodiment.

Electromagnet MG1 is arranged in series with a switch 228 which is normally opened and is locked in its closed position only when the coupling member 16 is locked in its connecting position, by the armature of the electromagnet MG1 so that coupling and switch are released together upon energization of said electromagnet. Another switch c221 arranged in series with switch 228 is controlled by the feeler of the metering device MD4 sliding on the perforated tape.

Electromagnet MG3a is arranged in series with two switches 229 and u234 which are arranged in parallel to one another, switch 229 being normally open, and locked in its closed position by the armature of electromagnet MG3a only when the coupling member 14 is closed by the key ⑭ but not when closed by the general control handle U. Switch 229 is in series with switch c221 which has been described already in connection with switch 228.

Switch u234 which is to be locked in its closed position by the armature of electromagnet MG3a only when the coupling member 14 is locked in its connecting position by the general control handle U and not when connected by the key ⑭, is in series with the switch c222 which is controlled by the feeler on reel 111 so as to be held open against the bias of a spring as long as there is any recording medium wound on the reel 111, and closed only when it is empty. Thus the recording medium itself acts as a metering device.

In parallel with the circuit of switch *u*234 of the electromagnet MG3*a* is connected to switch *c*222 another circuit containing in series the electromagnet MG5*a* and the switches 236 and *u*238 of which switch 236 is normally open and is locked in its closed position only when the coupling member 110 is locked in its disengaged position by the armature of electromagnet MG5*a* so that both are released as soon as this electromagnet becomes energised. Switch *u*238 is controlled by the general control handle U.

As above stated this embodiment operates in conformity with the system represented in Fig. 19*a*.

Accordingly, when the general control handle U is set to its "recording" position (I), winding back (4) preparatory to actual recording (1) is initiated as the first period of the "recording" phase; the motor M is started by the closing of switch *u*13 (Fig. 13), coupling member 14 is engaged and locked in its engaged position by the armature of electromagnet MG3*a* (Fig. 18) and concurrently the switches 250 (Fig. 17) and *u*234 (Fig. 18) are closed and locked in their closed positions by the armature of electromagnet MG3*a* and coupling member 110 which was disconnected on setting of the general control handle U to its "intermediate" position (II) is now locked in its disconnected position by the armature of the electromagnet MG5*a*.

With the motor running and coupling member 14 engaged, the recording medium is wound back onto reel 112 (Figs. 12 and 12*a*).

Metering device MD1 is inoperative during this period (4) (compare Fig. 20) for the following reasons: on the one hand, closing of switch *u*245 is ineffective on electromagnet 304 (Fig. 17), since coupling member 16 is disconnected and accordingly switch 244 is open during this period (4): on the other hand, switches 246, 247 and *u*248 of electromagnet 305 are all in their open positions.

As winding back of the used up portion of the insulating tape is not necessary before starting a new "recording" phase, metering device MD4 is rendered inoperative during this period (4), switch 249 in the circuit of its electromagnet clutch 306 being in its normal open position and closing of switch 250 being ineffective with switch *u*251 open in the "recording" position (I) of the general control handle U.

When in the course of winding back the recording medium, the reel 111 therefor (Figs. 12 and 12*a*) has become empty the hitherto open switch *c*222 is closed. Consequently with switch *u*234 being still locked in its closed position by the armature of electromagnet MG3*a* this electromagnet becomes now energised and releases coupling member 14 and switch *u*234 so that they return to their disconnected and open positions, respectively.

Coupling member 110 for the control shaft 2 (Fig. 12) has been locked in its disconnected position on the general control handle U being set to its "recording" position (I), by the armature of electromagnet MG5*a* (Fig. 18). Now with switch 236 also locked in its closed position and switch *u*238 having already been closed by the general control handle U at the beginning of the "recording" phase (I), said electromagnet MG5*a* also becomes energised upon closing of switch *c*222, so as to release the coupling member 110 and switch 236 to return to their connected and open positions, respectively.

The first period (4) of the "recording" phase (I) is thereby terminated and the apparatus is now ready to record incoming messages. A calling relay similar to relay H (Fig. 7 or Fig. 1) or any suitable known form of calling relay may serve to start the motor M and, with the coupling member 110 is in its connected position, to initiate all operations controlled by the control shaft 2 as fully described with reference to the foregoing embodiments.

As the length of the messages to be recorded is not now dependent on an automatic device such as the disc 113 (Fig. 12) each individual recording is terminated by the relay responsive to the voice current.

As already briefly described above, the circuit, of a punch operating electromagnet (not shown) is temporarily closed either by the calling relay or by the relay (not shown) responsive to the voice current so as to perforate the insulating tape of the metering device MD4 either at the beginning or at the end of a message respectively.

The metering devices operate during actual recording (1) in the following manner:

Switch *u*245 being in its closed position since the beginning of the "recording" phase (I) and switch 244 being closed on coupling member 16 being engaged by the control shaft 2 after a predetermined number of revolutions of the motor M (in the same manner as described with reference to the other embodiments), the electromagnetic clutch 304 is energised and connects the metering device MD1 to the reel 111 of the recording medium which is now driven through the coupling member 16, so as to meter forward the length of the recording medium used up for recording.

Switch *u*248 is in its normal open position, the other electromagnetic clutch 305 of this metering device is switched off, so that the closing of switch 247 is ineffective in this period (1).

As soon as the recording medium begins to be wound on reel 111, switch *c*222 immediately returns to its open position so as to be ready for temporary closure again as soon as the reel 111 becomes empty again when the next winding back is completed.

With coupling member 16 engaged, switch 249 in the circuit of the electromagnetic clutch 306 is closed and accordingly metering device MD4 is coupled to reel 111 so that the insulating tape is wound in the same direction as the recording medium. Electromagnet 307 is ineffective with both switches 250 and *u*251 open during this period (1).

The coupling member 16 may, for example, be disengaged at the termination of a call, due to the falling off of the voice controlled relay. For this purpose an additional contact may be provided on this relay which energises the magnet MG1 when the relay falls off.

This cycle of operations is repeated every time an incoming message is recorded.

As already briefly described above, the apparatus is automatically switched off when the total capacity of the recording medium has been exhausted. This switching off may be effected by a switch (not shown) arranged on the drum of reel 112 (Figs. 12 and 12*a*), which switch is held in its closed position as long as there is any recording medium available on said reel 112 but is opened under the bias of a spring as soon as it is no longer depressed by the recording medium.

Before the total capacity of the recording medium has been exhausted, the apparatus is

ordinarily switched off to terminate the "recording" phase (I), by setting the general control handle U to its "intermediate" position (II) whereby all the changes of connections are effected which have been fully described with reference to the foregoing embodiments, and particularly, the coupling member 110 is set to its disconnected position where it is locked by the armature of electromagnet MG5a when the general control handle U is moved to its "recording" position (I) as already mentioned hereinbefore. Moreover in order to perforate the insulating tape of metering device MD4 at the beginning of the recording of each incoming message, a second switch (not shown) shunting the switch of the punch operating electromagnet, which is operated by the calling relay H (Fig. 7 or Fig. 1), is temporarily closed by setting the general control handle U to its "intermediate" position so as to perforate the insulating tape of the metering device MD4 once more at the end of the last recorded message.

When now the general control handle U is set to its "reproducing" position (III) all the changes of connections are effected as described with reference to the foregoing embodiments when initiating the first period (3b) of the "reproducing" phase (III). Particularly, the coupling member 14 is engaged and is locked together with the switch u234 (Fig. 18) in the engaged and closed position respectively, by the armature of electromagnet MG3a. Moreover in the present embodiment, by setting the general control handle U to its "reproducing" position (III), the switches u245 (Fig. 17), and u238 (Fig. 18) are opened and switches u248 and u251 (Fig. 17) are closed.

Switches 246 and 250 are closed when coupling member 14 is connected as above described.

When now during the first period (3b) of the "reproducing" phase (III), the recording medium is wound back preparatory to actual reproduction, the metering devices operate as follows:

Metering device MD1 is inoperative due to the following reasons: switches 244 and u245 of electromagnet 304 are both open. Closing of switch u248 in the circuit of electromagnet 305 is ineffective since switch 246 is open, being closed only when the coupling member 14 has been connected by the key ⑭, which coupling member however, has been connected this time by the general control handle U.

With switch 249 open and switches 250 and u251 closed the metering device MD4 is also coupled with the reel 111, so that its associated insulating tape is also wound back.

As however switch 229 is open, coupling member 14 having been connected by the general control handle U and not by the key ⑭, the electromagnet MG3a is not energised upon closing switch c221 and winding back (3b) preparatory to reproducing, is completed without intersuption. As soon as reel 111 has become empty, however, switch c222 is closed, electromagnet MG3a is energised so as to release the coupling member 14 and switch u234 to return to their disconnected and open positions, respectively.

The second period (3) of the "reproduction" phase (III), namely actual reproducing, is started by depressing the key ⑯ of the coupling member 16 whereby this coupling member is locked in its engaging position by the armature of electromagnet MG1 together with switch 228 (Fig. 18) and switches 244 and 247 (Fig. 17).

The metering devices operate now during winding of the recording medium onto reel 111 for reproduction as follows:

Electromagnet 304 of metering device MD1 is inoperative with switch u245 open, electromagnet 305 is energised by a current passing by way of switches u248 and 247, so as to couple the metering device MD1 to the reel 112, now rotating in the reverse direction.

Metering device MD4 is coupled by electromagnet 306, (being energised with switch 249 closed) to the forwardly rotating reel 111 of the recording medium. Electromagnet 307 is ineffective with switch 250 being open. As soon as a perforation in the insulating tape passes under the contact feeler of switch c221 (Fig. 18) however, electromagnet MG1 is energised by a current passing the closed switch 228 whereby the coupling member 16 and switch 228 are released so as to return to their disconnected and open positions, respectively. By again depressing the key ⑯ of the coupling member 16, reproduction of the next recorded message is started in the same way as described hereabove.

For repetition of the reproduction of an individual record, the key ⑭ for the coupling member 14 must be depressed so that this coupling member is locked in its engaged position and the switches 229 (Fig. 18) and 246, 250 (Fig. 17) are locked in their closed positions by the armature of electromagnet MG3a.

As the motor keeps rotating, the reel 112 is now driven so as to wind back the recording medium.

The metering device MD1 meters forwardly the length of the wound back portion of the recording medium in the same manner as in the first period (3b) of the "reproducing" phase (III). Metering device MD4 also meters backwardly, but as coupling member 14 has not been connected by the general control handle U but by the key ⑭ of coupling member 14, switch 229 (instead of switch u234) is locked in its closed position by the armature of electromagnet MG3a. Accordingly as soon as switch c221 is closed when a perforation in the insulating tape of the metering device MD4 passes under the contact feeler, electromagnet MG3a is energised so as to release the coupling member 14 and switch 229 from their connected and closed positions respectively, so that winding back of the recording medium is stopped.

By repeatedly depressing the key ⑭ of the coupling member 14, winding back may however be extended to any earlier record. Repetition is initiated upon depressing the key ⑯ of coupling member 16.

When all recorded messages have been reproduced, reel 111 has again become empty and accordingly switch c222 is closed and switch u234 being closed again energises the electromagnet MG3a so as to release coupling member 14 and switch u234 to return to their disconnected and open positions, respectively.

The feeler on reel 111 which controls the switch c222 also opens the switch c8 (Fig. 13) which during the "reproducing" phase (III) is of no effect as switch u13 is not closed, but which during the "recording" phase (I) opens the motor circuit at the end of the winding back (4) preparatory to recording (1).

In the present embodiment, the motor circuit is opened at the end of the reproduction of the last call and not as in the case of the two previously described embodiments, when the coupling key ⑯ is again depressed after the re-

production of the last call. In order that the last call recorded may be reproduced repeatedly with the present embodiment also, switch *c6* which cuts out the motor circuit is shunted by a switch *c5b* (represented in dotted lines in Fig. 13), which is closed during depression of key ⑩ actuating coupling member 14.

The insulating tape which according to this embodiment is perforated in conformity with the calls made, may alternatively be pre-perforated at intervals corresponding to the duration of normal calls so that the present embodiment involves a prescribed duration of call, provided that the coupling member 16 is also locked in engagement by a cam or other device on the control shaft 2 for recording, and switch 228 is simultaneously closed as above described with reference to another embodiment. In this case the tape of the metering device MD4 may be permanently coupled to the spools 111, 112 or an endless insulating tape may be used which may always run in the same direction or it may be reversed together with the spools 111 or 112.

The metering device MD1 and the feeler control of switch *c222* may be designed as described in connection with the present embodiment or they may be replaced by counting mechanisms CM1, CM2 and CM3 as denoted in connection with a foregoing embodiment and in such case derive their control from the metering device MD4 in the same manner as in the previous embodiment the control was derived from the cam disc 113.

Several embodiments of the invention, in which messages are recorded in alignment on a regenerative medium have been described. With slight modifications, however, the apparatus may also be adapted for use with a record medium which is not to be regenerated in the apparatus.

In such an apparatus recording (1), winding-back (3*b*) for reproduction, and reproduction (3) are necessary as in the foregoing embodiments, so that there are no differences in connection with the counting mechanisms CM1 and CM2 (Fig. 14).

A difference consists in that the record medium is not wound back when reproducing is finished, but recording is continued from the place at which the last record ends. Accordingly the spooling back period (4) preparatory to recording (1) is eliminated from the ordinary cycle of operations.

After reproduction of the last recorded message, the recording and pick-up means are positioned with respect to the recording medium at the beginning of the unused portion of the medium, and the counting mechanisms CM1 and CM2 have returned to their initial positions. When now a new period of actual recording (1) is started, counting mechanisms CM1 and CM2 start counting again from their initial positions and the subsequent winding back (3*b*) preparatory to reproducing, is switched off by counting mechanism CM2 as soon as this has returned to its initial position, which corresponds to the beginning of the recently recorded series of messages.

Spooling back is effected only when all the recording medium has been used up. It is preferable to wind back the medium before exchanging so that only one spool has to be exchanged. Therefore the counting mechanism CM3 during actual reproduction (3) registers all the messages recorded on the medium actually in use and when switch *u11* (Fig. 11) is set to *b*, *c* for medium changing (IV), (preferably by pushing a separate key not shown) then the counting mechanism CM3 counts back all the calls wound back and switches-off the apparatus when it has reached its initial position. Switch *c7* is opened by the counting mechanism CM2 reaching its end position when the capacity of the medium is exhausted.

Various changes may be made in the details disclosed in the foregoing specification without departing from the invention or sacrificing the advantages thereof.

We claim:

1. In apparatus for recording telephone messages in a subscriber's absence and for subsequently reproducing such messages in combination, a single control handle for controlling said apparatus and having a plurality of operating positions, a plurality of means controlled by said control handle for connecting the apparatus to a telephone line and preparing the apparatus for incoming messages, for disconnecting the apparatus from the telephone line and connecting a telephone instrument to said line, and for reproducing recorded messages while the apparatus is disconnected from the telephone line, the operation of said apparatus being divided into periods during which actual recording and actual reproducing take place, periods during which preparation for recording and preparation for reproducing are effected and periods of rest, said periods being grouped together into three adjacent phases, a recording phase, an intermediate phase and a reproducing phase, in such manner that the control handle when set to any of its positions terminates one phase and simultaneously initiates an adjacent phase, a metering device adapted to limit the operation of the apparatus during recording and reproduction, and during preparation therefor to steps of predetermined length, counting mechanisms adapted to count the number of messages recorded, reproduced and repositioned during preparation for recording and reproducing and, on reaching predetemined settings, to change the mechanical and electrical connections of the apparatus, thereby automatically terminating periods other than the last one of a phase or initiating periods other than the first one of a phase.

2. In apparatus for recording telephone messages in a subscriber's absence and for subsequently reproducing such messages, in combination, a single control handle for controlling said apparatus and having a plurality of operating positions, a plurality of means controlled by said control handle for connecting the apparatus to a telephone line and preparing the apparatus for incoming messages, for disconnecting the apparatus from the telephone line and connecting a telephone instrument to said line, and for reproducing recorded messages while the apparatus is disconnected from the telephone line, the operation of said apparatus being divided into periods during which actual recording and actual reproducing take place, periods during which preparation for recording and preparation for reproducing are effected and periods of rest, said periods being grouped together into three adjacent phases, a recording phase, an intermediate phase and a reproducing phase, in such a manner that the control handle when set to any of its positions terminates one phase and simultaneously initiates an adjacent phase,

metering devices, one of which is adapted to meter the length of the individual messages recorded, reproduced and repositioned during preparation for repetition, and the other (MDI) of which is designed to cumulatively meter the length of the messages recorded, reproduced and repositioned during preparation for repetition, and, on reaching a predetermined setting, to change the mechanical and electrical connections of the apparatus, thereby automatically terminating the period of actual reproducing, a recording medium and a switch which is normally held open by the recording medium itself and is closed thereby at the ends of the periods of preparation for recording and preparation for reproducing so as to terminate said periods.

3. Sound recording and reproducing apparatus whereby telephone messages may be recorded in a subscriber's absence for subsequent reproduction comprising in combination, means for recording and reproducing messages including a record carrier, and a single control handle for connecting the apparatus to a telephone line, and for effecting all the necessary mechanical and electrical changes whereby the means for recording and reproducing, and the record carrier are automatically brought into their correct relative positions for recording, and for reproducing from the earliest recorded message not previously reproduced.

4. Apparatus according to claim 1, comprising recording and reproducing devices including a recording medium and in which the phases of operation initiated by setting the control handle to its recording and reproducing positions are each subdivided into at least two periods, during the first of which periods the recording medium and the recording or reproducing device are positioned with respect to one another, preparatory to actual recording or actual reproducing, respectively, and during a second of which periods, the actual recording or actual reproduction takes place.

5. Apparatus according to claim 2, comprising recording and reproducing devices including a recording medium and in which the phases of operations initiated by setting the control handle to its recording and reproducing positions are each subdivided into at least two periods, during the first of which periods the recording medium and the recording or reproducing device are positioned with respect to one another, preparatory to actual recording or actual reproducing, respectively, and during a second of which periods, the actual recording or actual reproduction takes place.

6. Apparatus according to claim 1, comprising recording and reproducing devices including a recording medium and in which the phase of operations initiated by setting the control handle to its reproducing position is subdivided into at least three periods, during the first of which periods the recording medium and the reproducing device are positioned with respect to one another preparatory to actual reproduction, during the second of which periods, the actual reproduction takes place and during the third of which periods the recording medium and the recording device are positioned with respect to one another preparatory to actual recording.

7. Apparatus according to claim 1, comprising a key for initiating during the reproduction phase each step subsequent to the first one independently.

8. Apparatus according to claim 2, comprising a key for initiating during the reproduction phase each step subsequent to the first one independently.

9. Apparatus according to claim 2 in which the metering device, which meters the length of individual messages recorded, comprises means for stopping reproduction when the length of the reproduction is equal to the length metered.

10. Apparatus according to claim 3, comprising devices for positioning the reproducing means for reproduction of the next message and means for effecting repetition of a message by rendering said devices inoperative.

11. Apparatus according to claim 1, in combination with a device adapted to measure the total length of all messages recorded by counting the number thereof, to regulate the readjustment preparatory to the actual reproducing period, and to terminate this readjustment period when the readjustment is equivalent to the total length of the messages recorded.

12. Apparatus according to claim 1 in combination with a counting mechanism, which is arranged to count the total number of all messages reproduced and to deduct therefrom the number of messages repeated, and to control the readjustment period prior to the next actual recording and to terminate this readjustment period when the number of messages counted is equivalent to the number of messages reproduced.

13. Apparatus according to claim 1, in which a counting mechanism serving to count the recorded messages during recording is arranged to render the apparatus inoperative to receive the next message, as soon as the counting mechanism has reached its maximum position, corresponding to the maximum capacity of the record medium.

14. Apparatus according to claim 1, comprising a recording medium adapted to record messages in alignment, a plurality of reels for winding thereon and unwinding therefrom said record medium, comprising a switch in the motor circuit and spring-loaded feeler arranged to open said switch when that reel, on which the record medium is wound during readjustment, is empty.

15. Apparatus according to claim 2, comprising a recording medium adapted to record messages in alignment, a plurality of reels for winding thereon and unwinding therefrom said record medium, comprising a switch in the motor circuit, and spring-loaded feeler arranged to open said switch when that reel, on which the record medium is wound during readjustment, is empty.

16. Apparatus according to claim 1, comprising a motor, a recording medium, a coupling member for coupling the recording medium to the motor, manually operable keys for actuating said coupling member for the reproduction of a message and for readjustment preparatory to its repetition, respectively, and a metering device for disconnecting said member.

17. Apparatus according to claim 1, comprising a driving motor, a recording medium adapted to be unwound and wound back, a coupling member for coupling the recording medium to said motor, control means for actuating said coupling member for recording, reproducing and winding-back an individual message, and a metering device for disengaging said coupling member.

18. Apparatus according to claim 1, comprising an electric circuit, an electromagnet having an

armature in said circuit, a coupling member locked to said armature in its connecting position, a switch in said circuit, and a metering device adapted to close said switch whereby to energize said electromagnet and to release said coupling member.

19. Apparatus according to claim 2, wherein one of the metering devices comprises an insulating tape pre-perforated at distances corresponding to equal lengths of messages, and two spools supporting said tape, said apparatus further comprising a record medium and spools supporting said record medium, said first-named spools being adapted to be alternatively coupled to said last-named spools, so that the tape is wound forwards for recording and reproducing and is wound backwards for readjustment, and a switch adapted to be closed by the metering device each time that it is passed by a perforation in said insulating tape.

20. Apparatus according to claim 3, comprising a record medium, a motor for actuating said medium zones of conductive layers provided on that side of said medium which is not recorded on, and a switch adapted to be closed by said zones for disconnecting the record medium from the motor.

21. Apparatus according to claim 3, comprising two counters each including a ratchet wheel, an electromagnet and a pawl adapted to be operated by said electromagnet and to rotate said wheels stepwise in the same direction.

22. Apparatus according to claim 3, comprising a motor, two electromagnets connected in parallel with one another and including an energizing circuit, a switch in said circuit and adapted to be closed by said motor, and another switch controlled by the general control handle during recording and reproducing, respectively, and prevented from closing during repetition, for alternatively switching in said electromagnets.

23. Apparatus according to claim 3, comprising a motor, an electromagnet including an energizing circuit and a switch in said circuit adapted to be closed by said motor, another switch adapted to be closed by the general control handle for switching in said electromagnet during reproduction, and a third switch arranged in series with said second switch and adapted to be opened during repetition.

24. Apparatus according to claim 3, comprising recording means and pick-up means provided separate from one another, the first being operative only during recording and the other only during reproducing, a single regenerative record medium and record effacing means preceding said recording means.

25. Apparatus according to claim 3, comprising recording means and pick-up means provided separate from one another, the first being operative only during recording and the other only during reproducing, a single regenerative record medium and record effacing means preceding said recording means, the record medium comprising longitudinal zones of magnetizable material embedded in a broad band of non-magnetizable material, so as to form parallel zones.

26. Apparatus according to claim 3, comprising recording means and pick-up means provided separate from one another, the first being operative only during recording and the other only during reproducing, record effacing means preceding said recording means, and several magnetizable wires being arranged side by side so as to form parallel record media.

27. Apparatus according to claim 3, wherein two record media are arranged to be completely recorded on alternatively so that each is exchangeable independently of the other, the phase being completed when both record media are completely recorded on, two different switches being connected in parallel with one another, two separate and similar cams one of which corresponds to the one carrier band and the other to the other band, and extensions on said cams for controlling said switches.

28. Apparatus according to claim 1, comprising a motor, an amplifying device including amplifier valves, said valves including plate circuits, and a retarding relay for preventing the motor from being started prior to heating up of said valves connected with one of said plate circuits.

29. Apparatus according to claim 1, wherein the counting mechanism comprises a counter and four switches, said switches being connected in an energising circuit in series with a switch which is permanently closed only during an actual reproducing period, a cam disc 4 temporarily closing said switch during the other periods, said four switches being arranged in two pairs, one of each pair being controlled by the general control handle so as to be closed during recording and opened during reproduction, and the other of each pair each being controlled by a separate manually operable key, one pair of said switches being connected in series with an electromagnet arranged on energisation to move a counter of the counting mechanism one step forwardly, the other pair of said switches being connected in series with an electromagnet arranged on energisation to move the counter of the counting mechanism one step backwardly, a switch in the energising circuit being set by the general control handle for connecting the first electromagnet to the energising circuit only during recording, and for connecting both electromagnets to the energising circuit during reproducing, and a further switch connected in the energising circuit in series with said switch which is opened only during the two periods of readjustment of the recording medium.

30. Apparatus according to claim 3, comprising a pick-up means, an abutment, and a step-by-step gear, and wherein a counting mechanism is provided which comprises a spring biased toothed wheel having an extension and being permanently coupled to the pick-up means so that during recording its spring is loaded and said extension is moved away from said abutment on which it bears in the initial position of the counting mechanism, and to which it is returned by the bias of the spring when the recording and pick-up means is disconnected from said step-by-step gear, thereby readjusting the recording and pick-up means with respect to the recording medium.

31. Apparatus according to claim 1, comprising two electromagnets including armatures and wherein one of the counting mechanisms in its initial position closes a switch in the circuit of said electromagnets by the armature of one of which a coupling member is locked in its connecting position for readjusting preparatory to recording, and in the armature of the other, a further coupling member and all connections of the electro-acoustic circuits are locked in their positions for reproduction, two switches connected in series one with each of the electromagnets being normally open and being closed by levers retaining the coupling members in their connected and disconnected positions, respectively.

32. Apparatus according to claim 1, wherein in one of the counting mechanisms, four switches connected together on one side are connected on that side in series with a switch, which is permanently closed during the actual reproducing period only and is temporarily closed by the metering device defining the length of an individual message, during the other periods, which four switches are arranged in two pairs one of each pair each being controlled by the general control handle so as to be closed during reproduction, and the other of each pair each being controlled by a separate key, electromagnets for actuating the counter forwardly and backwardly, respectively, being each connected in series with one pair of said switches, and a further switch being set by the general control handle so as to connect one electromagnet only during recording and to connect both electromagnets during reproducing to a switch in series with said switch, this switch being opened during recording and during readjustment for reproduction.

33. Apparatus according to claim 3, wherein two record media are arranged to be completely recorded on alternatively so that each is exchangeable independently of the other, the phase being completed when both record media are completely recorded on.

34. Apparatus according to claim 33, comprising pick-up means and recording means including at least one record medium on which the messages are recorded in parallel tracks, the record medium being wound forwards once during each actual recording period and during each actual reproducing period, the recording and pick-up means being moved at the end of each period transversely of the record medium over a distance corresponding to the space between two adjacent tracks, which spaces are all equal except when passing from one band to the other, and a cam for producing said transverse movement comprising two spiral portions having a steeper portion for effecting the passage of the recording and pick-up means from the band to the other one.

35. Apparatus according to claim 1, in which three electric current branches are arranged in parallel with one another, one for use during recording, one for use during reproducing and one for use during readjusting, readjustment preparatory to recording being combined with recording in a single "recording" phase.

36. Apparatus according to claim 1, in which two electric current branches are arranged in parallel with one another, one for use during recording and the other for use during reproduction, both readjustment periods being combined with reproducing so as to form a single "reproducing" phase having three periods.

37. System for recording and reproducing incoming messages at a telephone substation connected to the exchange line, comprising in combination, a circuit bridging said line, recording means and auxiliary apparatus such as a reply pick-up and a signalling device connected in series with said circuit, a plurality of switches for individually shunting said recording means and said auxiliary apparatus, a motor for operating said recording means, said switches being adapted to be normally closed but to be opened under control of said motor whereby to put the associated apparatus into effective connection with said line.

38. System according to claim 37, comprising a relay arranged in the exchange line circuit and adapted to be energized by the current coming therefrom, a switch controlled by said relay which when closed causes an engaged signal to be communicated to the calling subscriber, by connecting an exchange line wire to an earth wire, provided that a further switch controlled by the operating motor and arranged in series with the first-named switch is closed, a still further switch being arranged in series with the aforementioned switches and a speed control device such as a centrifugal governor for controlling said further switch, so as to keep said further switch closed as long as the speed of the operating motor is maintained normal.

39. System according to claim 37, comprising an amplifier having an input valve and a grid, and in which modulated currents from the exchange line are conducted through a shunt to the grid of the amplifier input valve, whereas the direct current from the exchange line passes through a choke, and a potentiometer for coupling the amplifier input to the shunt circuit.

40. System according to claim 37, having a further switch in the exchange line circuit and speed controlled means adapted to keep said further switch closed as long as the speed of the operating motor exceeds a predetermined value.

41. System according to claim 37, in which a switch is arranged to be opened after a predetermined number of revolutions of the operating motor during a further predetermined number of revolutions, said switch being shunted across a signalling device, whereby the sound frequency alternating current produced by said signalling device is conducted to the exchange line.

42. System according to claim 37, comprising an amplifier including valves, the various parts being arranged so that the time from the switching-in of the amplifier to the closing again of the switch shunting the signalling means, is longer than the time required to heat-up the valves of the amplifier.

43. System according to claim 37, comprising an amplifier having an input valve and a grid, and in which modulated currents from the exchange line are conducted through a shunt to the grid of the amplifier input valve, whereas the direct current from the exchange line passes through a choke.

44. In an automatic sound recording and reproducing device for receiving messages from and transmitting messages into a telephone exchange line, a calling relay adapted to be connected to the exchange line and to be energised by the alternating ringing current, a plurality of contacts connected in series with respect to one another and in parallel to the said calling relay, a supply of electric current, a motor adapted to be connected to said supply and to control the said contacts, and a series of elements to influence and to be influenced by the exchange line direct current respectively, one of said elements being adapted to be influenced by the exchange line talking current, and each of said elements being connected in parallel to one of the said contacts so as to be shunted in and out depending upon predetermined numbers of revolution of the said motor.

45. In an automatic device for recording and reproducing messages received from a telephone exchange circuit, an amplifier, an input valve in said amplifier, a choke and a condenser to be connected in parallel to each other in the exchange circuit so as to form an alternating current shunt, and means to connect said condenser to the grid of the said input valve, whereby the

talking current modulations are transmitted to said amplifier while the direct current is passed by said amplifier through said choke.

46. In an automatic sound recording and reproducing device, an automatic sound recording and reproducing device comprising in combination a sound receiving and reproducing assembly, a device to automatically restore the said assembly to the starting point of the last recorded message and a device to automatically switch-off the said assembly, a valve amplifier for the talking currents and an automatic sound volume regulator in the said amplifier for compensating the differences in the intensity of the receiving alternating currents.

47. In an automatic sound recording and reproducing device a sound record carrier, a sound writing and pick-up means movable lengthwise for recording and reproducing and transversally between recording and reproducing with respect to the said carrier, a gauge element adapted to measure the length of the record taken, means adapted to restore said writing and pick-up means and the said carrier relatively to one another, an adjustable stop controlled by the said gauge element so as to limit the restoring of the said writing and pick-up means with respect to said carrier to the beginning of the last taken record, means to adjust said stop during reproduction of said record to a position corresponding to the end of the latter and a fixed stop corresponding to the very beginning of the sound record on the said carrier.

48. In an automatic sound recording and reproducing device, a band of definite length serving as a sound record carrier, a writing and pick-up means adapted to be brought into operative relation with the said band, a pair of spools to spool said band on and off respectively, a step by step gear arranged for cooperation with said writing and pick-up means so as to cause transverse displacement thereof with respect to the said band between recording and reproducing, resilient means adapted to be tensioned by said transverse movement and, when released to restore said writing and pick-up means transversally to the said band, means to automatically connect the said step by step gear with one of the said spools when the latter spools the band on and to disconnect said gear from said spool, when the latter spools the band off, and means to disconnect said step by step gear at will from the said spool.

49. In an automatic sound recording and reproducing device for receiving messages from and transmitting messages into a telephone exchange line, a first sound writing and pick-up means, an amplifier adapted to be connected to the exchange circuit on the one hand and to said first writing and pick-up means on the other hand, a first sound record carrier arranged for cooperation with said first writing and pick-up means for recording and reproducing messages of a calling subscriber to the called subscriber, a second sound record carrier, a second pick-up for reproducing from said second carrier messages prepared by the called subscriber to the calling subscriber, and means to connect said second pick-up to the exchange line prior to the amplifier and to keep said second pick-up out of operation during operation of said first writing and pick-up means.

50. In an automatic sound recording and reproducing device for receiving messages from and transmitting messages into a telephone exchange line, a sound record carrier for recording messages of a calling subscriber and reproducing said messages to the called subscriber, a motor, a gear adapted to variably couple the said motor to the said sound record carrier, and a second sound record carrier adapted to communicate messages prepared by the called subscriber to the calling subscriber, the said second sound record carrier being actuated by the said gear prior to the said first sound record carrier.

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