

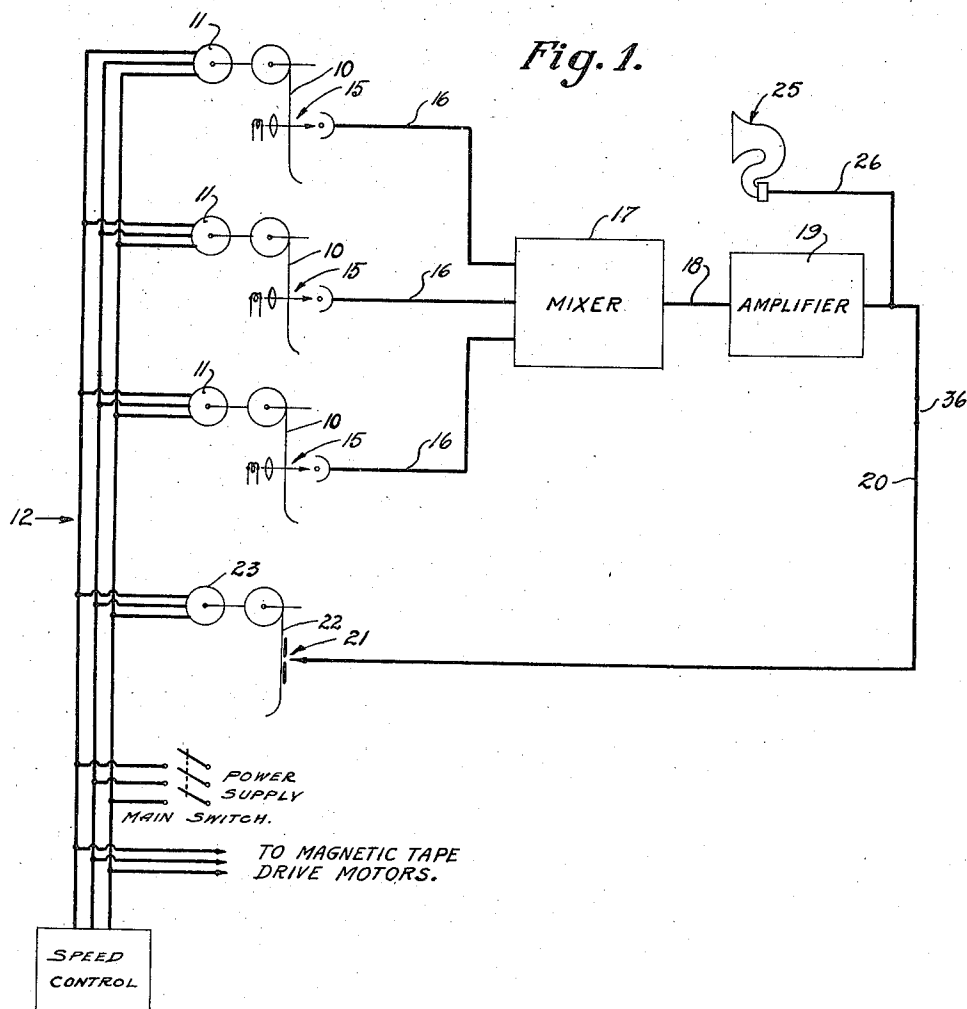
Feb. 4, 1941.

H. S. HELLER ET AL

2,230,949

AUTOMATIC SOUND PICTURE DUBBING SYSTEM

Original Filed Jan. 18, 1937 2 Sheets-Sheet 1



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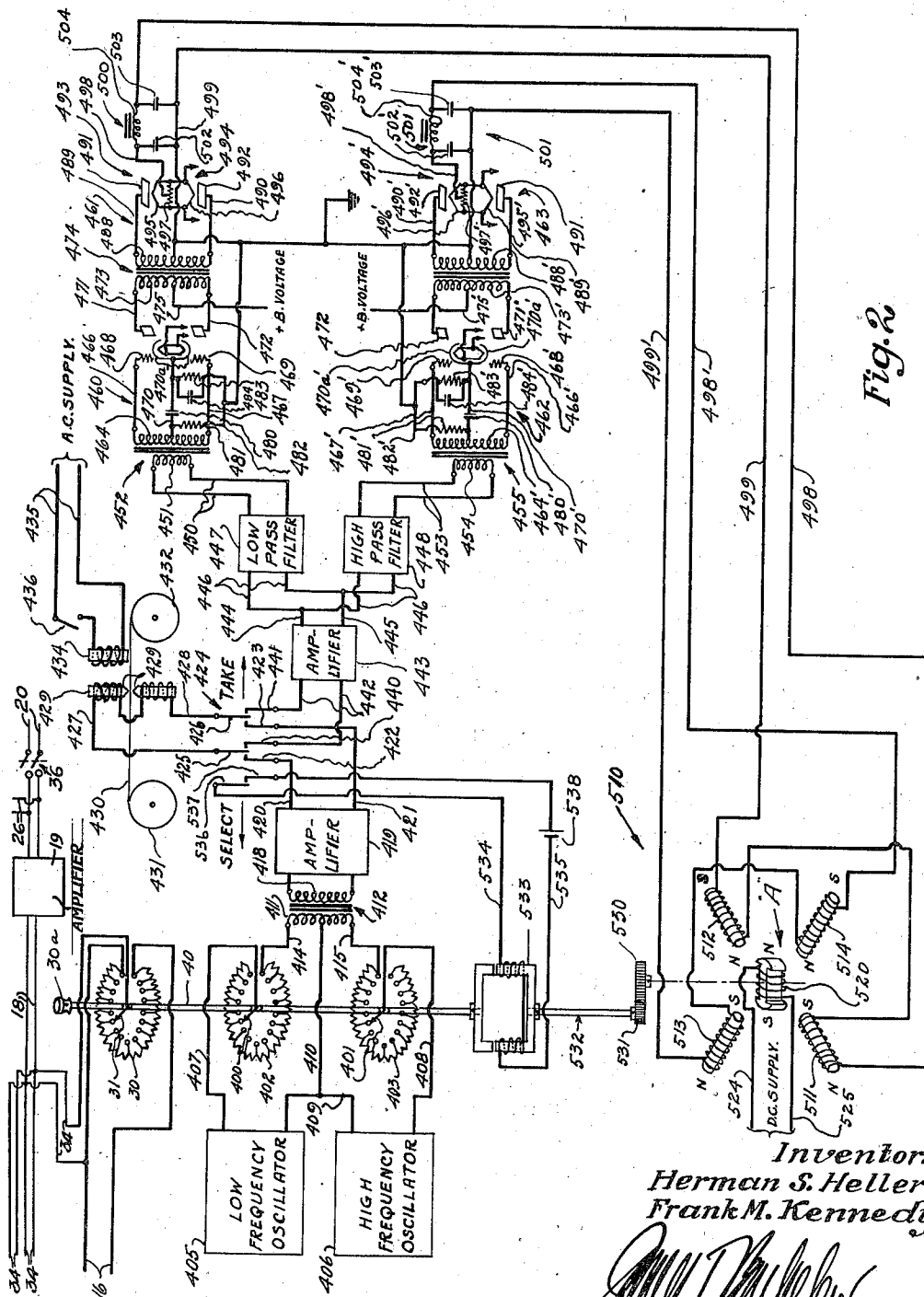
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UNITED STATES PATENT OFFICE

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AUTOMATIC SOUND PICTURE DUBBING
SYSTEMHerman S. Heller, West Los Angeles, and Frank
M. Kennedy, Los Angeles, Calif.; said Kennedy
assignor to said HellerApplication January 18, 1937, Serial No. 121,100
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11 Claims. (Cl. 179—100.3)

This invention relates generally to the art of dubbing motion picture sound records, and deals more particularly with automatic dubbing systems for motion picture sound records.

5 The expression "dubbing" as applied to sound pictures contemplates three varieties of operations, namely, scoring, or adding incidental music to an existing sound record, synchronizing, or adding background sound effects at appropriate places in the originally taken sound record, and simple re-recording, that is, recording an original record for instance at a different volume level, or with desired volume modifications. These three classes of dubbing operations may of course be performed singly or in combination.

10 In practice, an original or existing sound record is run synchronously with a sound record or records having the incidental music or sound effects to be dubbed in, the electrical sound currents reproduced from such component records, are mixed at the desired volume levels by a mixer, and the resulting composite electrical sound current is recorded on the new record. An operator, called a mixer, operates a series of volume change devices or faders controlling the relative amplitudes of the several electrical sound currents combined within the mixer. This operator is furnished with a loud speaker or monitoring horn from which the resultant composite electrical sound current is audibly reproduced simultaneously with recording on the new record, and by listening to this reproduction and simultaneously operating his controls, the mixer attempts to control the amplitudes of the several input currents in such manner as to combine them at proper relative amplitudes to produce the desired combination sound record. If a mistake in judgment is made, and a sound is recorded at too high or too low volume, the whole operation must be performed over again. The work is highly tedious, and is in reality impossible to complete to satisfaction. Many retakes are made, with a resultant wastage of film, and the final product is invariably no more than a rough compromise with the actual result wanted.

45 It is the object of the present invention to provide an "automatic" dubbing system, enabling the desired volume levels or changes to be individually predetermined for each component or dummy record before any recording on film is done, after which the component records may be run simultaneously and their output mixed and recorded under automatic mixer control.

50 The system in one aspect may be considered as a pantograph, wherein a series of executed

motions of the fader may be repeated or reproduced at any time in the future. In other words, the system of the present invention reproduces automatically the movements of the mixer made while he is manipulating his mixing or volume controls, but this reproduction is accomplished at any desired time in the future. This reproduction in fact is a "play back" of the original movements of the mixing or volume control members which, thereby, causes the same degree of volume control as the operator or mixer originally effected. In other words, the "play back" is an accurate replica of the original movement of the mixing or volume control settings.

15 The invention in all its aspects, including its various objects and corresponding accomplishments, will be best understood without further preliminary discussion by referring now to the following detailed description of a present illustrative embodiment thereof, reference being had to the accompanying drawings, in which:

Fig. 1 is a schematic diagram showing a typical dubbing system; and

20 Fig. 2 is a schematic diagram of an illustrative automatic control unit in accordance with the present invention, it being understood that the mixer unit indicated in Fig. 1 is to be provided with one such control unit as is shown in Fig. 2 for each component record of the complete dubbing system.

25 Reference is first directed to Fig. 1, showing a typical dubbing or re-recording system. A plurality of sound records 10, here indicated as of the motion picture film type, are indicated as synchronously driven by synchronous motors 11 fed from a common three wire distributing system 12. The records 10 may contain different sounds to be combined on the final film; for instance, one may contain the original talking record, another may bear incidental music, another sound effects, such as the sound of a closing door, a pistol shot, etc. These several records are of course so prepared and driven as to synchronize with one another. The synchronizing system here indicated, comprising motors 11 and distributing system 12, may be of a type well known in the art, it being understood that each motor 11 connected across distributing system 12 will run in exact synchronism with each other such motor so connected.

50 Optical and photo-electric means for producing electrical sound currents from the records contained on films 10 are diagrammatically indicated at 15, and the electrical circuits which conduct

such sound current to the mixing unit are indicated at 16.

Circuits 16 are connected into a mixer 17, which as heretofore known comprises a system for combining the electrical sound currents carried by the several input circuits into a single output circuit, together with individual manually controllable resistors, known as faders, for regulating the amplitudes, and therefore the volume level characteristics, of the input currents received from circuits 16. These resistors, which are of well known type and need not be illustrated in Fig. 1, thus serve to regulate the volume level characteristics of each input sound current, and after such regulation, the several currents are combined in a conventional manner within the mixer and are delivered to a common output circuit 18.

Output circuit 18 is shown as going to amplifier 19, and the output of amplifier 19 is conducted by way of circuit 20 to an electro-optical recording means at 21 which records the composite electrical sound current on final film 22. This final film 22 is indicated as driven by a synchronous motor 23 also connected across distributor system 12.

A monitor horn 25 enabling the operator controlling mixer 17 to hear the result of the volume changes which he imposes is indicated as connected via circuit 26 to amplifier output circuit 20.

It will be understood that, in accordance with prior practice, the mixer operator maintains a constant manual control over the faders controlling the amplitudes of the several component sound currents which are combined within the mixer and delivered to the single output circuit going to the final recorder. It will also be understood that in the event this operator should make a mistake in judgment as to the volume at which one sound current should be mixed with the others, that mistake will not show up until the new record 22 has been developed, a print taken therefrom and that print reproduced.

The present invention provides means whereby the successive positions and changes of positions of each mixer fader during the manually controlled run may later be automatically reproduced.

Fig. 2 shows one of the input circuits 16, which will be understood to carry the electrical sound current produced by reproduction of one of the films 10, and shows said circuit 16 going to the terminals of a fader 30 of conventional type. The fader is shown provided with the usual control arm 31 adapted to wipe over fader contacts 32, and the output circuit 34 leading from the fader is connected as usual across one side of input circuit 16 and fader arm 31. It will be understood without further description how resistor or fader 30 controls the amplitude of the electrical sound current carried by circuit 34 leading from the fader in accordance with the setting of fader arm 31 on contacts 32. It will be understood that the fader and its connections may be of any suitable or conventional nature, so long as its operation controls the attenuation of the sound current delivered to circuits 34 and 18.

It is to be understood that there is one fader, such as 30, controlling each input circuit 16, and a unit or system such as shown in Fig. 2 for automatic control of each such fader 30. It will also be understood that the circuit 34 leading from each fader 30 is so connected within the mixer to the corresponding circuits 34 leading

from the other faders as to combine the several fader controlled sound currents within the single output circuit represented at 18. Such mixer circuits are well understood in the art and need not here be shown in detail, though in Fig. 2 I conventionally indicate several fader circuits 34 as connected into a common input circuit 18 leading to amplifier 19.

The automatic control unit of Fig. 2 will now be considered in more detail. Fader arm 31 is mounted on a manually rotatable shaft 40, which also carries the arms 400 and 401 of resistors 402 and 403, respectively. A low frequency oscillator 405 and a high frequency oscillator 406 are provided, the frequencies of which may typically be 50 cycles and 500 cycles, though it is to be understood that this illustration constitutes no limitation on the invention. One terminal of low frequency oscillator 405 is connected by lead 407 to the arm 400 of resistor 402, and one terminal of high frequency oscillator 406 is connected by lead 408 to arm 401 of resistor 403. The other terminals of oscillators 405 and 406 are interconnected by a lead 409, which is in turn connected by lead 410 to a center tap on the primary winding 411 of a transformer 412. Non-corresponding terminals of resistors 402 and 403 are connected by leads 414 and 415, respectively, to the outside terminals of transformer winding 411. That is, resistors 402 and 403 are so connected that as resistor arms 400 and 401 rotate in the same direction as shaft 40 is turned, the resistance in the circuit of one oscillator is decreased as the resistance in the circuit of the other oscillator is correspondingly or complementarily increased. Rotation of fader shaft 40 therefore causes the low frequency oscillator current input to transformer winding 411 to increase as the high frequency oscillator current input to said winding decreases, and vice versa, said currents varying always complementarily to one another.

The secondary winding 418 of transformer 412 is connected to the input terminals of an amplifier 419. The output terminals of amplifier 419 are connected by leads 420 and 421 to stationary contacts 422 and 423, respectively, of a control switch 424. Movable switch arms 425 and 426 are adapted to make with contacts 422 and 423, respectively, when moved toward the left, as viewed in Fig. 2. Connected to these switch arms 425 and 426 are circuit wires 427 and 428 leading to a recording means, preferably of the magnetic tape type, and are here shown as going to recording and reproducing magnets 429.

The magnetic recording tape 430 passes between recording and reproducing magnets 429 in the usual manner, the tape running from a supply reel 431 to a take-up reel 432, the latter being understood to be driven by a synchronous drive motor (not shown) powered from distributor system 12, while the supply reel is adapted to be driven by any suitable re-wind motor (not shown).

It will be evident that, switch arms 425 and 426 being moved over to the left, the low and high frequency oscillator currents, which are complementarily varied as the fader shaft is rotated, are mixed within transformer 412 and recorded together on tape 430.

The tape as here shown is provided with a separate erasing coil 434 adapted to be energized by an alternating current supply circuit 435 including a control switch 436. This circuit may be utilized to clean all or a portion of the magnetic record off the tape.

Switch arms 425 and 426 when moved to the right, as seen in Fig. 2, make with stationary switch contacts 440 and 441, which are connected across a circuit 442 leading to the input side of an amplifier 443. Thus, when tape 430 has been re-wound on reel 431, and is again run forwardly to reel 432, the complementarily varying (complementary amplitude) oscillator currents recorded on tape 430 are reproduced within coils 429, and are amplified at 443. The output leads 444 and 445 of amplifier 443 are connected across a circuit 446, which interconnects corresponding input terminals of a low-pass filter 447 and a high-pass filter 448. Low-pass filter 447 and high-pass filter 448 are thus both fed from the output of amplifier 443. Low-pass filter 447 is designed to pass substantially exclusively currents of a frequency corresponding to low frequency oscillator 405 and high-pass filter 448 is designed to pass substantially exclusively currents corresponding to high frequency oscillator 406. Such low and high-pass filters are well known in the art, and will require no explanation here.

Low-pass filter 447 is connected by leads 450 to the input winding 451 of a transformer 452, while high-pass filter is connected by leads 453 to the input winding 454 of a transformer 455.

The output of transformer 452 is amplified by a vacuum tube amplifier, generally designated at 460, and then rectified by a rectifier designated at 461, while the output of transformer 455 is amplified by a vacuum tube amplifier indicated at 462, and then rectified by a rectifier indicated at 463. As here shown, amplifiers 460 and 462 are of the push-pull type. Considering amplifier 460 in detail, the secondary winding 464 of transformer 452 is connected at its ends through leads 466 and 467 to the grid elements of two vacuum tubes 468 and 469, respectively, while the center tap of transformer 464 is connected by lead 470 to the heater elements 470a of tubes 468 and 469, as indicated. The plate leads 471 and 472 of tubes 468 and 469 are connected to the end terminals of the primary winding 473 of a transformer 474, while the center tap of winding 473 is connected by lead 475 to positive B voltage, as indicated.

Lead 470 includes a condenser 480, and connected to lead 470 between said condenser and transformer winding 464 is one end of a resistance element 481. The opposite end of resistance 481 is connected by wire 482 with one end of a second resistance 483, the other end of which is connected to lead 470 between condenser 480 and the heater elements of tubes 468 and 469. A condenser 484 is shunted across resistance 483.

The outside terminals of secondary winding 488 of transformer 474 are connected by leads 489 and 490 to the plate elements 491 and 492 of a pair of rectifier tubes 493 and 494, respectively. The filament elements 495 and 496 of tubes 493 and 494 are connected in parallel, as indicated and connected across such filament elements is a resistance element 497, to the center of which is connected an output lead 498. The other output lead 499 is connected to the center tap of transformer winding 488, as indicated.

It will be understood that the low frequency current passed by filter 447 will be amplified by amplifier 460, and that the resulting amplified low frequency current is rectified by tubes 493 and 494, so that output circuit 498, 499 carries an

amplified, rectified low frequency (50 cycle) current.

Amplifier 462 and rectifier 463 are the same as amplifier 460 and rectifier 461, respectively, members of amplifier 462 and rectifier 463 being identified with the same reference characters as have been applied to amplifier 460 and rectifier 461, but with primes annexed. Accordingly, output circuit 498, 499 carries a rectified 50 cycle current, while output circuit 498', 499' carries a rectified 500 cycle current.

Output circuits 498, 499 and 498', 499' are provided with π net works 500 and 501, respectively, each consisting of a pair of shunt connected condensers 502 and 503 and an intervening series connected inductance 504. These net works or filters are designed to take out the 50 and 500 cycle oscillation frequencies, passing only a uni-directional current wave bounded by the complementary envelopes of the 50 and 500 cycle waves received from the rectifiers, which envelopes will be understood of course to be determined by the movements of resistor control arms 490 and 491 during the making of record 430.

Circuits 498, 499 and 498', 499' are connected to a motor unit 510. This unit, in the illustrative form here shown, comprises a pair of opposed series connected field windings 511 and 512, connected in series with leads 498 and 499, and a pair of series connected field windings 513 and 514 connected in series with leads 498' and 499'. As here shown, the pairs of field coils 511—512, and 513—514 are disposed at 90° from one another, all being radially disposed with reference to the axis of rotation 0 of the motor armature. As here shown, adjacent coils 512 and 514 are wound and connected so that their north poles are at their inner ends, while coils 511 and 513 are so wound and connected that their south poles are at their inner ends.

The motor armature A consists of a winding 520, wound to provide a north pole at one side of the armature and south pole at the other, as indicated. Opposite ends of the winding are connected to direct current supply leads 524 and 525. The motor armature is normally positioned with its north pole side mid-way between the north poles at the inner ends of coils 512 and 514, and with its south pole side between the south poles at the inner ends of coils 511 and 513.

It will be evident that the motor armature will tend to rotate in a clockwise direction under the influence of the fields produced by coils 512 and 511, and will tend to rotate in a counter-clockwise direction under the influence of the fields produced by coils 513 and 514. The armature will accordingly under all conditions seek and take a position dependent upon the relative strengths of the currents flowing in said two pairs of field coils.

The armature of motor 510 has a range of operation of something less than 90° of rotation; accordingly, since a rotation of as much as perhaps 300° is desired to be imparted to the fader shaft, step-up gearing arrangements are employed. Thus, as here indicated, a gear 530 on motor shaft 523 drives a smaller gear 531 on a shaft 532.

Shaft 532 is adapted to be drivingly connected by magnetic clutch 533 with fader shaft 40. The winding of magnetic clutch 533 is connected by leads 534 and 535 to the movable arm 536 and

stationary contact 537, respectively, of control switch 424. Contact is made between said arm 536 and contact 537 when the switch is moved toward the right, to take position. A battery 538 is included in one of the leads leading to magnetic clutch 533, as indicated.

The operation of the system may now be understood. It is assumed that a series component sound record films 10 have been prepared, and that the speech, sound effects, or music recorded on said films have been so synchronized that when the several films are synchronously driven, the sounds recorded thereon may be reproduced in proper synchronous relation to one another. These films 10 are then run in the system of Fig. 1, each film being driven by its synchronous motor 11 energized from the central distributing system 12. Switch 36 is open, so that nothing will be recorded at this time, switch 424 is moved to the left, to "select" position, and the magnetic recorder is operated so as to drive tape 430 from supply reel 431 to take-up reel 432 in synchronous relation with the drive of the sound films 10. The sound records on the several sound films 10 are now all reproduced as electrical sound currents within circuits 16, and these currents flow by way of fader controlled circuits 34 and common mixer circuit 18 to amplifier 19, the output of which is reproduced by monitor horn 25. The mixer operator listens to the sound coming from the records 10 as reproduced by horn 25, and from time to time rotates the fader shafts 40 by means of knobs 39a so as to adjust the fader control arms 31 of the several faders 30 and thereby change the volume level of the several components of the reproduced sound as he may think desirable.

The rotation of each shaft 40 turns the corresponding arms 400 and 401 of resistors 402 and 403, respectively. As previously described, rotation of a fader shaft 40 in one direction increases the resistance of one of the resistors 402 and 403 as it decreases the resistance at the other, so that the amplitudes of the low frequency and high frequency oscillation currents flowing from oscillators 405 and 406 are simultaneously varied in opposite directions. That is, said currents are varied complementarily to one another.

Switch arms 425 and 426 being moved to the left, or to select position at this time, the two oscillator currents as thus complementarily controlled by resistors 402 and 403, are amplified at 419, and then flow by way of switch 424 to recording coils 429, the two currents, both low and high frequency, thus being recorded on magnetic tape 430.

At the end of the run, tape 430 is wound back from take-up reel 432 to supply reel 431, and switch 424 is shifted over to the right, to take position. Oscillators 405 and 406 are then out of the circuit, and coils 429 are connected by way of switch 424 to input amplifier circuits 442. Contact is also made between switch arm 536 and contact 537, energizing magnetic clutch 533, thus coupling motor shaft 523 with fader shaft 40.

The films 10 of Fig. 1 are run back to starting position, and film 10 and tape 430 are then synchronously driven in a forward direction, care being taken that the films 10 and tape 430 start synchronously. The run now to be made is simply for the purpose of checking the correctness of the amplitude changes which were manually effected during the preceding run, and recording switch 36 is therefore still left open at this time.

The high and low frequency complementarily varying current waves recorded on the tape 430 of each automatic unit are now reproduced within coils 429, are amplified at 443, and are divided at filters 447 and 448, so that the low frequency current wave flows exclusively in circuit 459, and the high frequency current wave flows exclusively in circuit 453. These current waves are amplified at 460 and 462, respectively, are rectified at 461 and 463, respectively, and flow in circuits 498, 499 and 498', 499' as complementarily varying direct current waves, the 50 and 500 cycle oscillator frequencies being removed at net works 500 and 501. It will be evident that these current waves represent the complementary resistance changes at resistors 402 and 403 during the manual control run of sound films 10.

These complementary varying currents then flow in the opposed pairs of motor field coils 511, 512 and 513, 514, so that the opposing rotative forces on motor armature A likewise vary complementarily, with the result that said armature shifts its position first one way and then the other from its mid position between said sets of field coils. For each pair of values of the complementary currents flowing in the opposing field coils, there is a position at which the opposing forces on armature A are in balance, and the armature therefore rotates back and forth under the control of the complementary current waves.

This movement of motor armature A is transmitted by way of shaft 523 and 532 and magnetic clutch 533 to fader shaft 40, the drive ratio at gears 530 and 531 being such that the rotation of fader shaft 40 so received from the motor armature duplicates the original manually effected rotations or movements of shaft 40 during the initial manually controlled run of sound films 10.

It will now be evident that as sound films 10 are audibly reproduced by way of circuits 16, 34, 18, amplifier 19 and circuit 26, the volume level of reproduction of the several records will be controlled by faders 30 under the automatic control of the records on the magnetic tapes 430. The volume changes manually effected during the initial manually controlled run may therefore be checked by the mixer before any recording on film is made. It will be evident that a single sound film 10 may thus be reproduced and checked in the manner here described, or a plurality of such sound films 10 may be run together with their several faders all under individual automatic control and the composite effect noted by listening to the reproduction from horn 25.

If a given sound is recorded at an undesirable volume level, the corresponding section of the record on tape 430 may be modified. To do this, the tape is rewound until the record portion to be modified is just before erasing magnet 434. Switch 436 is then closed, and the tape run forwardly, the erasing current flowing in the magnet 434 erasing the previously made record on the tape. The tape is of course stopped when the section of the record to be modified has passed the magnet 434 and been erased. Switch 424 then being thrown to select position, and the tape having been rewound the proper distance, a new position or set of positions of fader arm 31 may be recorded on the tape. Thus by this procedure the record on the tape may be modified in parts to correct earlier mistakes.

When the records on the tapes of all automatic fader control units are deemed to be satis-

factory, the recordation on film 22 may be made. The several sound record films 10 are then to be synchronously driven with the fresh negative film 22 on which the new composite sound record is to be recorded. Switch 36 is closed, switch 424 of each automatic unit is again in take position, and the magnetic tapes 430 having been rewound and the films 10 and 22 all being at their starting positions, the main switch controlling the synchronous motor distributor system is closed. This "run" is carried out in the same way as the previously described trial run, except that the switch 36 is closed and the final recording on film 22 is accordingly made. Thus the sound records on the several sound films 10 are reproduced as electrical sound currents within circuits 16, and these currents flow by way of fader circuits 34, and common mixer circuit 18 to amplifier 19. The output current from the amplifier flows to recording means 21, producing a composite sound record on film 22. The sound current flowing in each mixer circuit 34 is controlled in amplitude by its corresponding fader 30, which in turn is under the automatic control of the pre-established "fader-position" recording on tape 430. Thus each component sound current going into mixer circuit 18 is controlled in volume by its own automatic control unit in exact accordance with the manual volume level adjustments which were previously made during the "select" run for the corresponding sound film 10, and which are represented on the "fader-position" record of that automatic control unit.

The automatic system thus duplicates each manual volume level adjustment which was made during the "select" run, eliminating the possibility of mistakes in judgment in effecting volume level changes in the final recording on film, and therefore eliminating entirely retakes on film.

It will thus be understood that a record is made on the record element 430 of each automatic unit of the manually effected movements of the volume control fader 30 of that unit during the manually controlled run of sound films 10, and that in subsequent runs of films 10, both for trial purposes (with switch 36 open), without recording on film, and in the final run during which a final recording is made on film 22, said record 430 produces electrical currents which control an electric motor device drivingly connected to the same volume control fader for automatic duplication of the manual volume adjustments made during the initial or manually controlled run of sound films 10.

We have now illustrated and described certain specific illustrative means for carrying our invention into effect; it is to be understood, however, that the disclosure given is for illustrative purposes only, and that various changes, modifications, and substitutions may be made without departing from the spirit of our invention or of the appended claims.

We claim:

1. The herein described method, that comprises producing an electrical sound current from an original sound record, audibly reproducing said sound current, manually effecting desired amplitude modifications in said sound current by reference to such audible reproduction, making a record of such amplitude modifications, again producing an electrical sound current from said original sound record, repeating the same amplitude modifications in said electrical sound current under the control of said amplitude modifi-

cation record, and making a sound record of said amplitude modified electrical sound current.

2. The herein described method, that comprises producing an electrical sound current from an original sound record, audibly reproducing said sound current, manually controlling the amplitude level of the sound current as desired by reference to such audible reproduction, simultaneously making a record of the manually effected control operations, again producing an electrical sound current from said original sound record, effecting a control of the amplitude level of said sound current by use an electrical current produced by simultaneous reproduction of said last mentioned record, and making a sound record of said amplitude controlled sound current.

3. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, means for automatically controlling said fader comprising means for recording manually effected movements of the fader control member, and means controllable by the record so made for subsequently automatically effecting similar movements of said fader control member.

4. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, electric circuiting carrying two separately controllable electric currents, means for complementarily varying said currents in accordance with manually effected operation of said fader control member, means for recording said electric currents, means for subsequently reproducing said electric currents from the records so made, and electromagnetic means controlled by said two currents for operating the fader control member to reproduce the previously effected manual control operations of said member.

5. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, electric circuiting carrying two separately controllable electric currents, means for complementarily varying said currents in accordance with manually effected operation of said fader control member, means for recording said electric currents, means for subsequently reproducing said electric currents from the records so made, and electromagnetic means controlled by said two currents for operating the fader control member to duplicate the previously effected manual control operations of said member, said electromagnetic means comprising a field winding adapted to carry one of said currents and another field winding adapted to carry the other of said currents, said windings being disposed with the like magnetic poles in opposition to one another, a movable armature having a current carrying winding and arranged with one of its poles between and acted upon by said field winding poles, and a coupling between said armature and the movable control member of said fader.

6. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, electric circuiting carrying two separately controllable electric currents, means for complementarily varying said currents in accordance with manually effected operation of said fader control member, means for recording said electric currents, means for

subsequently reproducing said electric currents from the records so made, and electromagnetic means controlled by said two currents for operating the fader control member to duplicate the previously effected manual control operations of said member, said electromagnetic means comprising a field winding adapted to carry one of said currents and another field winding adapted to carry the other of said currents, said windings being disposed with like poles in opposition to one another, a movable armature having a magnetic pole between and acted upon by said field winding poles, and a coupling between said armature and the movable control member of said fader.

7. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, a pair of oscillators, one of higher frequency than the other, electric circuiting carrying electric currents generated by said oscillators, means for complementarily varying said oscillator currents in accordance with manually effected operations of said fader control member, means for recording said oscillator currents, means for subsequently reproducing said currents, means for rectifying said currents, and electromagnetic means controlled by the rectified currents for operating the fader control member in a manner to reproduce the previously effected manual control operations of said member.

8. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, a pair of oscillators, one of higher frequency than the other, electric circuiting carrying electric currents generated by said oscillators, means for complementarily varying said oscillator currents in accordance with manually effected operations of said fader control member, means for making a single record of said oscillator currents, means for reproducing an electric current from said record, a pair of filters for separating the current corresponding to the higher frequency oscillator from the current corresponding to the lower frequency oscillator, means for rectifying each of the resulting currents, and electromagnetic means controlled by the rectified currents for operating the fader control member in a manner to reproduce the previously effected manual control operations of said member.

9. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, a pair of oscillators, one of higher frequency than the other, electric circuiting carrying electric currents generated by said oscillators, means for complementarily varying said oscillator currents in accordance with manually effected operations of said fader control member, means for making a single record of said oscillator currents, means for reproducing an electric current from said record, a pair of filters for separating the current corresponding to the higher frequency oscillator from the current corresponding to the lower frequency oscillator, means for rectifying each of the resulting currents, means for filtering out the oscillator frequencies from the rectified currents, thereby producing a pair of unidirectional complementarily varying electric currents, and electromagnetic means controlled by the last mentioned currents for operating the

fader control member in a manner to reproduce the previously effected manual control operations of said member.

10. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, a pair of oscillators, one of higher frequency than the other, electric circuiting carrying electric currents generated by said oscillators, means for complementarily varying said oscillator currents in accordance with manually effected operations of said fader control member, means for making a single record of said oscillator currents, means for reproducing an electric current from said record, a pair of filters for separating the current corresponding to the higher frequency oscillator from the current corresponding to the lower frequency oscillator, means for rectifying each of the resulting currents, means for filtering out the oscillator frequencies from the rectified currents, thereby producing a pair of unidirectional complementarily varying electric currents, and electromagnetic means controlled by the last mentioned currents for operating the fader control member to duplicate the previously effected manual control operations of said member, said electromagnetic means comprising a field winding adapted to carry one of said rectified filtered currents and another field winding adapted to carry the other of said rectified filtered currents, said windings being disposed with like poles in opposition to one another, a movable armature having a current carrying winding and arranged with one of its poles between and acted upon by said field winding poles, and a coupling between said armature and the movable control member of said fader.

11. In a sound record dubbing system having a fader involving a movable manually operable control member adapted to control the amplitude of an electrical sound current, a pair of oscillators, one of higher frequency than the other, electric circuiting carrying electric currents generated by said oscillators, means for complementarily varying said oscillator currents in accordance with manually effected operations of said fader control member, means for making a single record of said oscillator currents, means for reproducing an electric current from said record, a pair of filters for separating the current corresponding to the higher frequency oscillator from the current corresponding to the lower frequency oscillator, means for rectifying each of the resulting currents, means for filtering out the oscillator frequencies from the rectified currents, thereby producing a pair of unidirectional complementarily varying electric currents, and electromagnetic means controlled by the last mentioned currents for operating the fader control member to reproduce the previously effected manual control operations of said member, said electromagnetic means comprising a field winding adapted to carry one of said rectified filtered currents and another field winding adapted to carry the other of said rectified filtered currents, said windings being disposed with like poles in opposition to one another, a movable armature having a magnetic pole between and acted upon by said field winding poles, and a coupling between said armature and the movable control member of said fader.

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