

Oct. 9, 1934.

B. E. ELDRED

1,975,928

METHOD AND MEANS FOR MAKING SOUND RECORDS

Filed Sept. 28, 1929

2 Sheets-Sheet 1

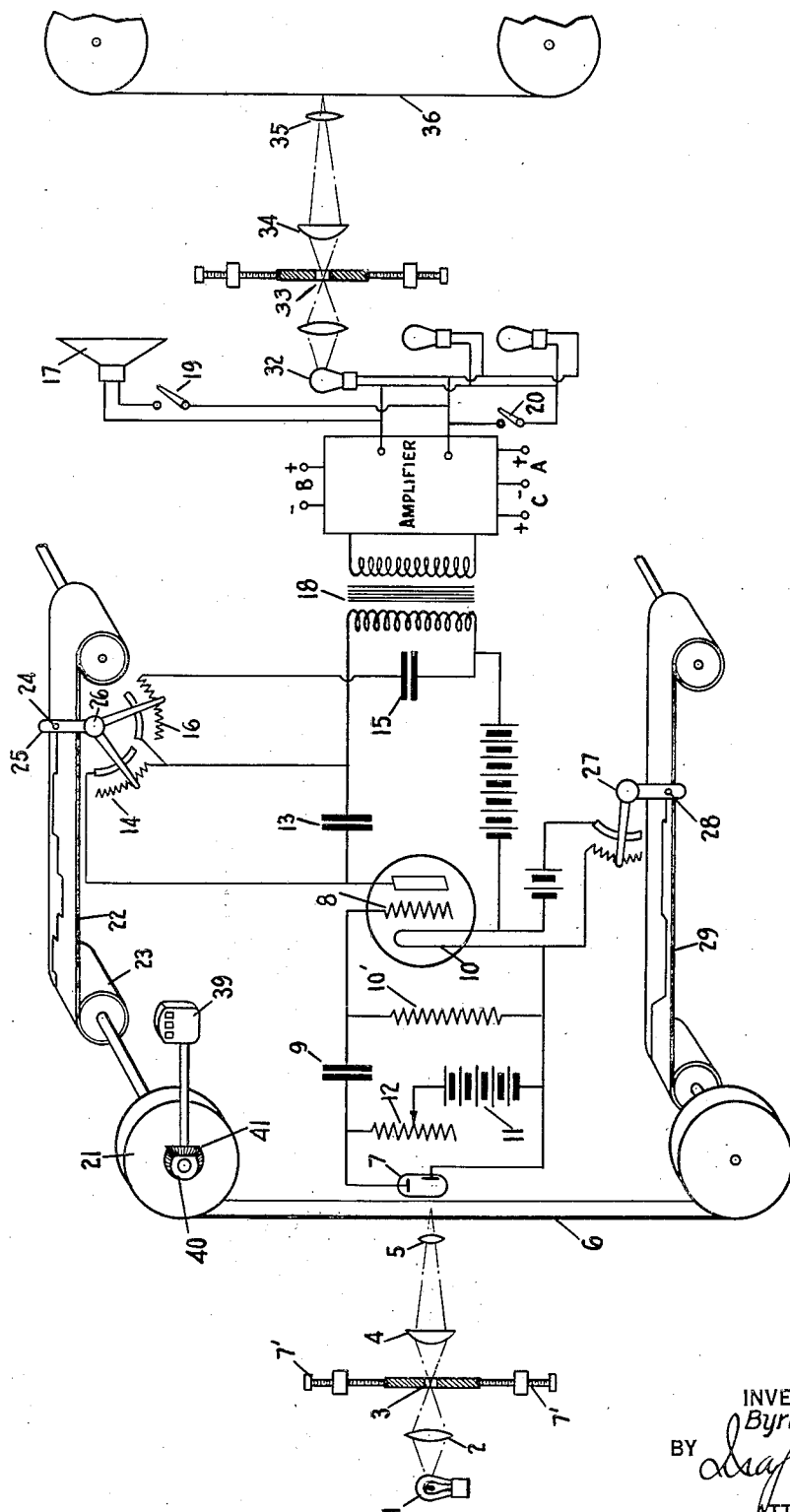


FIG. 1

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2 Sheets-Sheet 2

FIG. 2

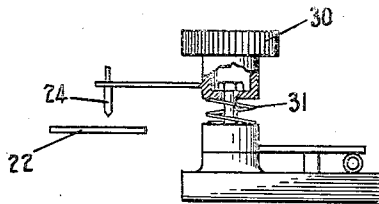


FIG. 3

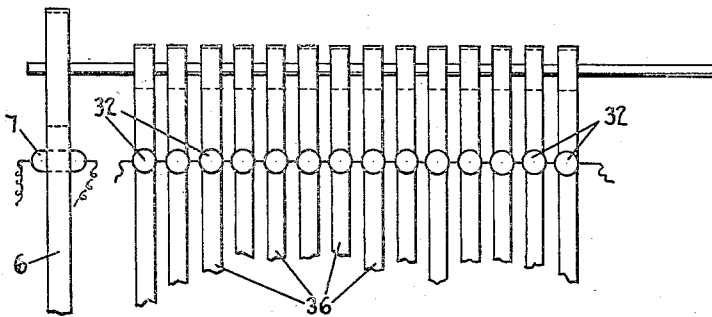
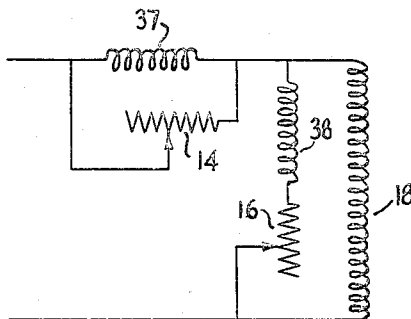


FIG. 4



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METHOD AND MEANS FOR MAKING
SOUND RECORDS

Byron E. Eldred, New York, N. Y., assignor, by
mesne assignments, to Radio Corporation of
America, a corporation of Delaware

Application September 28, 1929, Serial No. 395,819

14 Claims. (Cl. 179—100.3)

This invention relates to the methods of and means for making sound records with correctly balanced frequencies.

One object of the invention is to record with as little amplification of the recording electrical currents as possible to reduce undesired sounds.

Another object is to produce a record on which the high and low frequencies have been properly balanced.

Another object is to produce a master record and then make a sub-master record therefrom with proper balance of the frequencies, the sub-master record being then used to make standard or commercial records.

Another object is to make simultaneously a plurality of sub-master records.

Other objects will appear in the appended description, reference being had to the drawings in which:

Fig. 1 is a diagrammatic showing of apparatus for carrying out the method of the invention.

Fig. 2 is a detail view of the volume and frequency controls.

Fig. 3 is a view of a portion of a recording device to make a large number of sub-master films from one master film.

Fig. 4 is a diagram of a modified frequency discriminator.

In making sound records it has been usual to record by amplifying the electric currents produced by the sound before using those currents to produce the master record. I have found it preferable to record on the master record with little or no amplification as undesired sounds are less readily recorded.

Photophone records made by known processes are deficient in the high sounds. By this I mean that the intensity of the individual sound vibrations are not uniform. This is particularly noticeable in talking-motion pictures as the voices do not seem natural. The defect is equally present, however, in music and all other sound records made up of a plurality of frequency components.

By using prior processes of printing commercial records from the original master record it has been impossible to correct the difficulties above referred to as the commercial record is a reversed duplicate of the original. These difficulties have long been encountered but have not been remedied because of the tendency to follow known methods of printing records. I have interposed an extra step in the method of making what I call a sub-master record from the original record and then printing the commercial

records from the sub-master records. After making the original record I have skilled persons listen to the reproduction of sound from the original record and by means later described these persons make adjustment of a volume control to produce the desired amount of amplification at various points of the record by amplifying all frequencies at that point substantially alike.

I also have the skilled persons make adjustments of resistance and capacity or inductance circuits to amplify certain frequencies in respect to others. Specifically this brings out the high frequencies and depresses the low frequencies at various points of the record or vice versa. These adjustments in some cases make the record a faithful duplicate of the original frequencies and in other cases the sub-master record may be a great improvement on the original by bringing out the frequencies that are too low in volume to be satisfactorily heard even when made by the original singer or speaker.

The operators will mark in respect to the film the places at which the adjustments are made and the amounts of those adjustments. The original record will be run one or more times until the director is satisfied with the final reproduction as thus adjusted. Then the original record is run with light beams passing there-through and onto a photoelectric element. The varying currents from that element are then caused to produce varying light which is used to make another or sub-master record. The currents boosted or lowered by the attendants will produce the recording light and therefore the sub-master record will be either a true record of the original sound or will, as in some cases, be a great improvement over the original sounds.

The manner in which the foregoing and other advantages are secured will now be described in detail.

The original record may be made in accordance with any method and on any film emulsion, but I prefer to use the method and film emulsion employed in my Patent No. 1,655,811, January 11, 1928, and in my copending application filed Sept. 28, 1929, Serial No. 395,820. The invention claimed in my present application does not depend upon those features and therefore no method of making the original record is described herein.

After the original, or master, record is produced it is run through apparatus shown in the drawing in which 1 indicates a light of suitable type, beams from which are focused through lens 2 to illuminate a slot 3 for example, 2 mils wide.

Cylinder lens 4 taken in conjunction with lens 5 produces a real image of this slot in reduced width for example, one-half mil wide, on the moving master record 6. The light of this imaged slot passes through the sound track of the film and onto photoelectric cell 7 or other light sensitive element. The size and position of the slot 3 may be varied by means of adjusting screws 7' or by means shown in more detail in my application No. 245,634, filed January 9, 1928. The light passing through the film is automatically varied by the sound record thereon and this produces a corresponding variable current in the circuit connected to the cell. This circuit is as follows:

The anode of the cell 7 is connected to the grid 8 of a three electrode or other tube, through grid condenser 9. The cathode of the cell 7 is connected to the negative end of the filament 10. A grid leak resistance 10' is connected from the grid to the same end of the filament. Polarizing battery 11 has its negative terminal connected to the cathode of the cell 7 and its positive terminal connected to the anode through variable resistance 12.

The plate of the vacuum tube is connected to a suitable frequency control to increase the amplitude or intensity of certain of the components of the current in relation to the other components. That is, components of certain frequencies, for example, high frequencies, are increased or amplified in respect to others such as low frequencies or vice versa, I may use various frequency control means but I have shown in the drawing a frequency "filter" such as is described in the application of Lawrence M. Cockaday, filed Dec. 6, 1929, Serial No. 412,060, consisting of a series and shunt condenser and a resistance in series with the second condenser.

In order to make a record of the movement of the resistance controls, I have devised a special form of rheostat connected to these condensers. Condenser 13 is shunted by resistance 14 and condenser 15 is in series with resistance 16. Transformer 18 is connected in series with the condenser 13 and in shunt to the circuit containing condenser 15.

The current variations of the photo cell 7 impressed on the grid are transferred into the plate circuit in a well known manner. With all resistance cut out at 14 and 15 high and low frequencies will pass around condenser 13 with equal facility as the condenser is short-circuited. High frequency will pass readily through condenser 15 and very little will pass through transformer primary 18. The low frequencies, however, cannot so readily pass through condenser 15 because it is too low in capacity. Hence, most of the low frequency passes through the primary 18. In such position of the rheostat control, the high frequencies will be minimized and the low frequencies will pass in substantial full volume through the transformer, the amplifiers and the loud speaker 17.

When the rheostat control cuts in both resistances 14 and 16 to the full extent the high frequencies pass practically unimpeded through small condenser 13, but the low frequencies cannot pass so readily therethrough because the capacity is too low. The low frequencies also cannot pass to any extent through the shunt resistance 14 because it is now too high in value to let either low or high frequency through in substantial amount. Hence, when the current arrives at the primary of transformer 18 the "lows"

are at minimum volume and the "highs" at full value. The highs cannot readily pass through the shunt condenser 15 because the value of resistance 16 is now too high. The highs, therefore, go through the transformer 18, amplifiers and loud speaker 17. The condenser 13 has minimized the lows so that even though they could readily pass through the circuit of the primary 18 their effect in loud speaker 17 is much reduced. In this position the highs are at a maximum and the lows at a minimum.

Between these two extremes of the rheostat the highs and lows will be conversely varied. It will thus be seen that with such an arrangement I may control in any desired way the volume of the highs in relation to the lows and I can make a more perfect rendition of music or speech or other sound than is produced by the original sound producer such as a singer, or even a musical instrument itself. All that is needed is to have the true frequencies produced by such singer, etc. and the frequency control will produce a perfect balance of high and low frequencies. It is thus possible to produce an excellent rendition by an ordinary singer, or to produce substantially perfect rendition from any sound that is imperfectly balanced as to high and low frequencies.

In thus balancing the frequencies loud speaker switch 19 would be open and lamp switch 20 would likewise be open.

As the master record 6 is run off the reel 21 a paper or other strip 22 is wound onto reel 23 but preferably at a reduced speed.

As the frequencies are balanced, as just described, pencil 24 in arm 25 attached to rheostat control 26 draws a line to indicate the adjustments made.

Since I prefer to make the master record with little or no amplification, the director will boost or amplify all frequencies alike by any sort of volume control. These controls are well known in the art and I have illustrated a simple form for illustrative purposes. This consists of the usual rheostat 27 in the filament battery circuit. This usually would be placed in the filament circuit of one of the tubes in the amplifier, but to describe the invention it is sufficient to show it in the filament of the first vacuum tube. As the volume is varied the pencil or inker 28 will trace a line on the paper strip 29 run synchronously with the master film 6 but preferably at a reduced speed.

Due to the fact that the speaker may walk away from, or toward, the microphone in making the master record, and to other causes, it is likely that the volume control will be changed at various points along the paper strip. Such strip therefore may have a variously broken line traced by inker 28, but ordinarily it will not be so broken as the line traced on strip 22. This general volume adjustment may be made before or after the frequency adjustment is made at 26, or all may be made simultaneously.

It may be that the director will find it advisable to run the master record a number of times before his skilled ear is satisfied with the general volume produced by control 27 and the frequency balance produced by control 26, most likely the latter. In some cases the director will become so skilled with the apparatus that he can erase portions of the line traced on strip 22 or 29 and manually insert another broken portion. He could do this when he comes to a part of the record where he is not satisfied with the balance as determined by the operation of controls 26

and 27. In re-running the master film 6 and paper strips 22 and 29 the operators would keep the point of the pencil, along the line previously traced. This could be done with the design shown in Fig. 2, for example. When the operator desires the pencil to trace a line on the strip 22 or 29, knob 30 will be pressed down as it is rotated to balance the frequencies. When the operator desires to use the pencil 24, or 28, as a tracer only, in rebalancing, or in re-recording, to be later described, he will permit spring 31 to keep the pencil off the strip 22 and merely turn the knob 30 so as to hold the pencil point above the line. To maintain the pencil in this position it will be necessary to turn the knob as it was turned when the line was previously traced and thus in re-running the film the frequencies will be balanced, or the general volume controlled, as previously determined. At any place in rebalancing the operator can press the pencil down to change the marking. For this reason it is better to use a pencil at 24 and 28 instead of a pen. Any portion can then be readily erased and a new one drawn. After the record has been satisfactorily balanced and controlled as to general volume the lines may be retraced manually with pen and ink for a more permanent record.

When the desired balance of frequencies and the desired general volume is obtained the film and paper strips will be rewound for making the sub-master film. Lamp switch 20 should now be closed. The loud speaker 17 may be left in circuit or it may be cut out by opening the circuit switch 19. An equivalent impedance may be substituted if desired so as not to change the impedance of the circuit if the loud speaker is open circuited.

The master film 6 is then re-run at a much slower speed and sensitive film 36 is run synchronously therewith. The current passes through lamp 32 and as many other lamps as are needed to make the desired number of duplicate sub-master records, as later described. These lamps may be of the neon or any other type where current-changes produce, without lag, corresponding changes in light. The "sound" currents as amplified at 27 and balanced at 26 thus produce corresponding light changes at these lamps.

The light from lamp 32 is focused as before onto the slot 33 and lenses 34 and 35 produce a real image of the slot on sensitive film 36. A better record will be made in this case by using a slow substantially non-grain emulsion on film 36 and therefore the master film 6 and sub-master film 36 are preferably run at speeds that would produce unsatisfactory reproduction in loud speaker 17, but this is immaterial as it is now no longer necessary to listen to the loud speaker, hence it may as well be eliminated from the circuit.

A record is thus made on film 36 that is correctly balanced as to high and low frequencies and is properly made as to general volume. Such a record could not be made by prior processes because by either contact or optical printing the commercial record is a duplicate of the master record both as to general volume and frequency balance. By interposing an additional step in the process of making commercial records I have enormously improved such records.

A large number of sub-master films may be made by running a plurality of sub-master films off reels on the shaft connected to the master film reel. The photo cell 7 and the lamps 32

would be connected in the electrical circuits shown in Fig. 1. The lamps 32 may be connected in series, multiple, or in groups of series-multiple, as desired.

The invention may be used in putting sound and pictures on films simultaneously or on separate films to be combined either synchronously or non-synchronously with pictures. If the sound and pictures are taken on the same master record, the pictures can be optically printed on the sub-master record 36 in proper position at the time the revised sound is recorded in this film. The way to do this is obvious and is not shown as it would complicate other features. If sound and pictures are taken on separate films to form two master records they can be combined on sub-master film 36 in known ways or separate picture and sound films may be sold for synchronous running in reproducing apparatus. Instead of controlling both resistances 14 and 16 with one knob I may use two separate knobs so that each resistance may be changed independently of the other. Also, a plurality of condensers may be used for the series and shunt condensers, each one having a different capacity with its own separate resistance. With such an arrangement greater discrimination can be made between frequencies. However, in practice such fine discrimination will not be necessary and the arrangement of Fig. 1 is highly satisfactory.

Two inductances 37 and 38 may be substituted for condensers 13 and 15 as shown in Fig. 4, but the discrimination against high and low frequencies would be somewhat different from the operation already described. With resistance 14 all in very little of the highs and substantially all of the lows would pass through the series impedance consisting of resistance 14 and inductance 37. With it all cut out both highs and lows would pass therethrough. With all the resistance 16 cut in both the highs and the lows would be unable to go through the shunt impedance consisting of inductance 38 and resistance 16 and both would go through the primary 18 to produce their sound effects. With resistance 16 all cut out, the lows would be shunted around primary 18 but the highs would still go through the primary.

Instead of marking the adjustments and recording them on the paper strips 22 and 29 I may use a speed-counter such as 39 connected to the drum 21 by bevel gears 40 and 41. The operators would then note the scale reading of rheostats or other controls 26, 27 and also the revolutions indicated on counter 39 at such time. Then on re-running the film for recording on film 36 the settings will be duplicated at the correct points on the film 6.

There are also many other ways of recording or securing the desired volume changes in the sub-master record and my invention is not limited to the use of any particular arrangement.

After producing the sub-master records commercial records may be made by the usual contact or optical printing method to make the large quantities for home use or the sub-master records may be used directly as commercial records. This is practical as there is almost no limit to the number of submaster films that can be made at one running of the master film. In fact, for microscopic records for use in talking books, as described in my above mentioned application, I prefer to make the commercial records by the electrical method of Fig. 3.

Various other modifications may be devised without departing from the spirit of the invention as defined by the claims.

Having described my invention, what I claim

5 is:

1. The step in the method of re-recording from a sound record which consists in moving said record to produce in a circuit containing impedance an electrical current with components
10 having frequencies proportional to the frequencies of the recorded sounds, varying the impedance to alter the value of certain of said components in respect to the others and indicating the extent of variation of the impedance and the
15 time thereof in respect to the movement of said record.

2. The method of re-recording from a sound record which consists in moving said record to produce an electrical current with components
20 having frequencies proportional to the frequencies of the recorded sounds, varying the value of certain of said components in respect to the others, indicating the extent of said variations and the time thereof in respect to the movements
25 of said record, re-running said record to produce an electrical current, varying the current in accordance with said indication and using said current to produce another record.

3. The method of re-recording from a sound
30 record which consists in moving said record to produce an electrical current with components having frequencies proportional to the frequencies of the recorded sounds, varying the value of certain of said components in respect to the
35 others, indicating the extent of said variations and the time thereof in respect to the movements of said record, re-running said record to produce an electrical current, varying the current in accordance with said indications, producing
40 light pulses from said current and directing such light pulses on to a moving sensitive film to produce a new record.

4. The step in the method of re-recording from a sound record which consists in moving said
45 record to produce in an electrical circuit containing impedance an electrical current with components having frequencies proportional to the frequencies of the recorded sounds, varying the impedance to alter the value of certain of
50 said components in respect to the others and making a guide record of the extent of the variations of said impedance and the time thereof in respect to the movement of said record to facilitate the re-recording of the record with the same
55 variations.

5. The step in the method of re-recording from a sound record which consists in moving said record to produce an electrical current with components having frequencies proportional to the
60 frequencies of the recorded sounds, varying the value of certain of said components in respect to the others and making a guide record, re-running said record to produce an electrical current, varying the current in accordance with said
65 guide record and using said current to produce another record.

6. The step in the method of re-recording from a sound record which consists in moving said record to produce an electrical current with components having frequencies proportional to the
70 frequencies of the recorded sounds, varying the value of certain of said components in respect to the others, making a guide record of the extent of the variations, re-running said record to produce an electrical current, varying the current in
75

accordance with said guide record, producing light pulses from said current and directing said light pulses on to a moving sensitive film to produce a new record.

7. In phonographic apparatus, a sound record, means for moving said record, means positioned
80 in respect to said record to produce an electric current having frequency components corresponding to the frequency components of the sound recorded on said record, means to vary at
85 will the value of certain of the frequency components of said current in respect to other components thereof and means to indicate the extent of said variations and the time thereof in respect to the movements of said sound record. 90

8. In phonographic apparatus, a film having a sound record, a light source, a photoelectric cell, an electrical circuit connected to said cell, means to move said film and project light from
95 said source through said film and on to said cell to produce a current in said circuit having frequency components corresponding to the sound record on said film, means to vary at will the value of certain of the frequency components of
100 said current in respect to other components and means to indicate the extent of said variations and the time thereof in respect to the movements of the film.

9. In phonographic apparatus, a sound record, means for moving said record, means positioned
105 in respect to said record to produce an electrical current having components corresponding to the frequency components of the sound recorded on said record, means to vary at will the value of certain of the frequency components of said current in respect to other components thereof, a
110 guide record blank moving at speeds proportional to the speed of the moving record and means to indicate the extent of said variations on said guide record blank. 115

10. In photographic apparatus, a sound record, means for moving said record, means positioned
120 in respect to said record to produce an electric current having frequency components corresponding to the frequency components of the sound recorded on said record, means to vary at will the value of certain of the frequency components of said current in respect to other components thereof, means to indicate the extent of
125 said variations and the time thereof in respect to the movements of said sound record, and means influenced by said current to produce a new record.

11. In phonographic apparatus, a film having a sound record, a light source, a photoelectric cell, an electrical circuit connected to said cell, means
130 to move said film and project light from said source through said film and on to said cell to produce a current in said circuit having frequency components corresponding to the sound record on said film, means to vary at will the value of
135 certain of the frequency components of said current in respect to other components, means to indicate the extent of said variations and the time thereof in respect to the movements of the film, means to produce light pulses proportional to the
140 value of said currents, a moving sensitive film and means to project said light pulses on to said sensitive film.

12. In phonographic apparatus, means to move
145 a sound record, an electrical circuit, means in said circuit adapted to produce electrical currents in said circuit corresponding to the sound recorded on said record, two impedances in said circuit, a resistance in shunt to one of said im- 150

pedances, a resistance in series with the other impedance, a common control for varying said resistances and a recording device associated with said control to record the extent of the movement of said control and the position of the sound record at the time said change was made.

13. In phonographic apparatus, means to move a sound record, means to produce an electrical current corresponding to the sounds recorded on said record, a pilot blank, means to move the pilot blank proportionally to the movement of the said record, two impedances in said circuit, a resistance in shunt to one impedance, a resistance in series with the other impedance, a common control for varying said resistances, and a recording device moved by said control to record on said

pilot blank the extent of the movement of the control.

14. In phonographic apparatus, means to move a sound record, means to produce an electrical current corresponding to the sounds recorded on said record, a pilot blank, means to move the pilot blank proportionally to the movement of the said record, two impedances in said circuit, a resistance in shunt to one impedance, a resistance in series with the other impedance, a common control for inversely varying said resistances and a recording device moved by said control to record the extent of the movement of the control on said pilot blank.

BYRON E. ELDRED. 90

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CERTIFICATE OF CORRECTION.

Patent No. 1,975,928.

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BYRON E. ELDRED.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 35, for "filter" read "tilter"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of November, A. D. 1934,

Leslie Frazer

(Seal)

Acting Commissioner of Patents.

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