

April 15, 1958

M. P. MATTHEW

2,831,095

VARIABLE FUNCTION VOLTAGE DIVIDER

Filed June 22, 1955

3 Sheets-Sheet 1

Fig. 1.

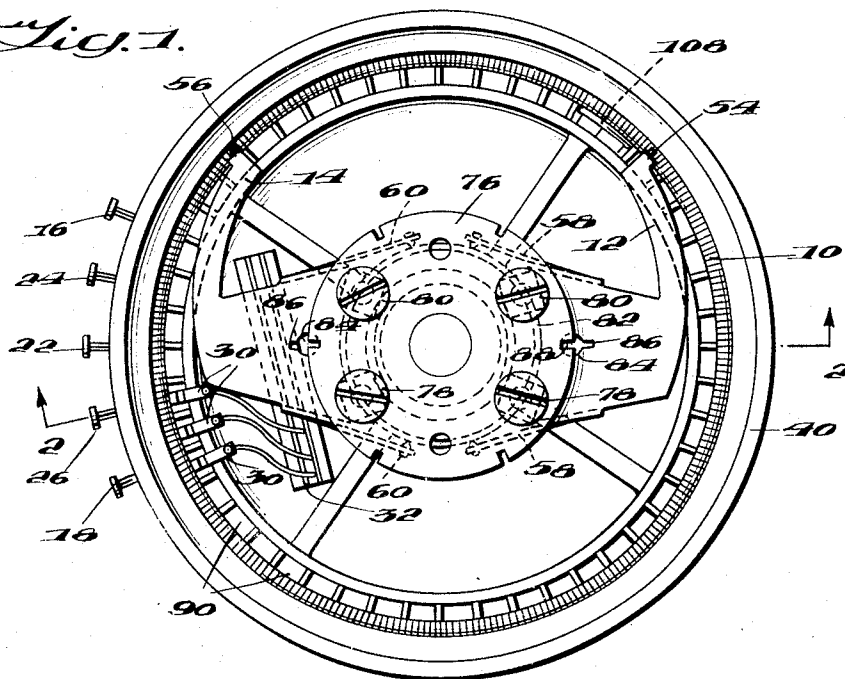
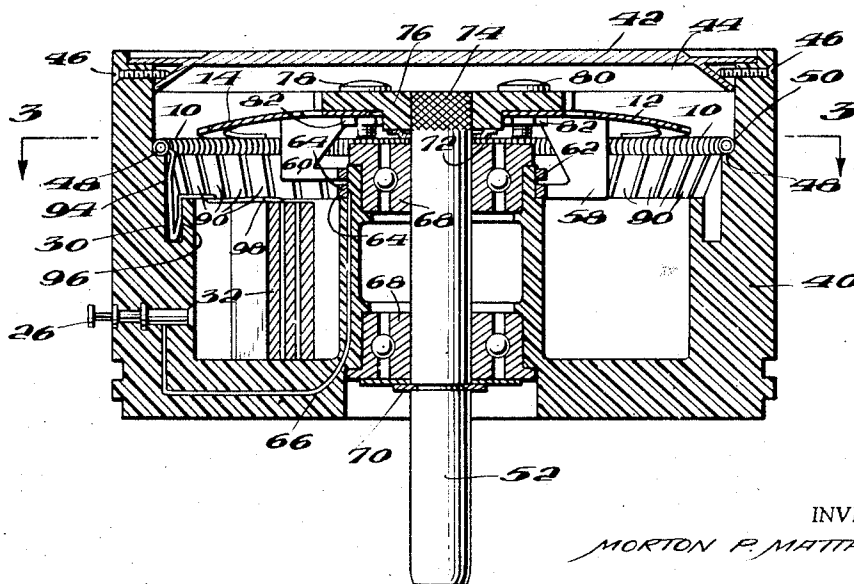


Fig. 2.



INVENTOR

MORTON P. MATTHEW,

BY

Fisher & Christen

ATTORNEYS

April 15, 1958

M. P. MATTHEW

2,831,095

VARIABLE FUNCTION VOLTAGE DIVIDER

Filed June 22, 1955

3 Sheets-Sheet 2

Fig. 3.

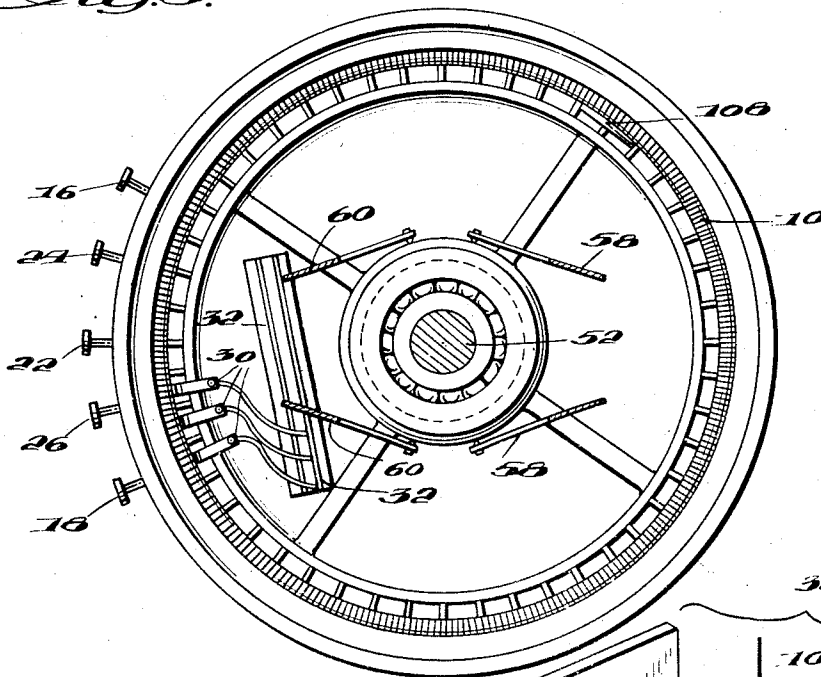
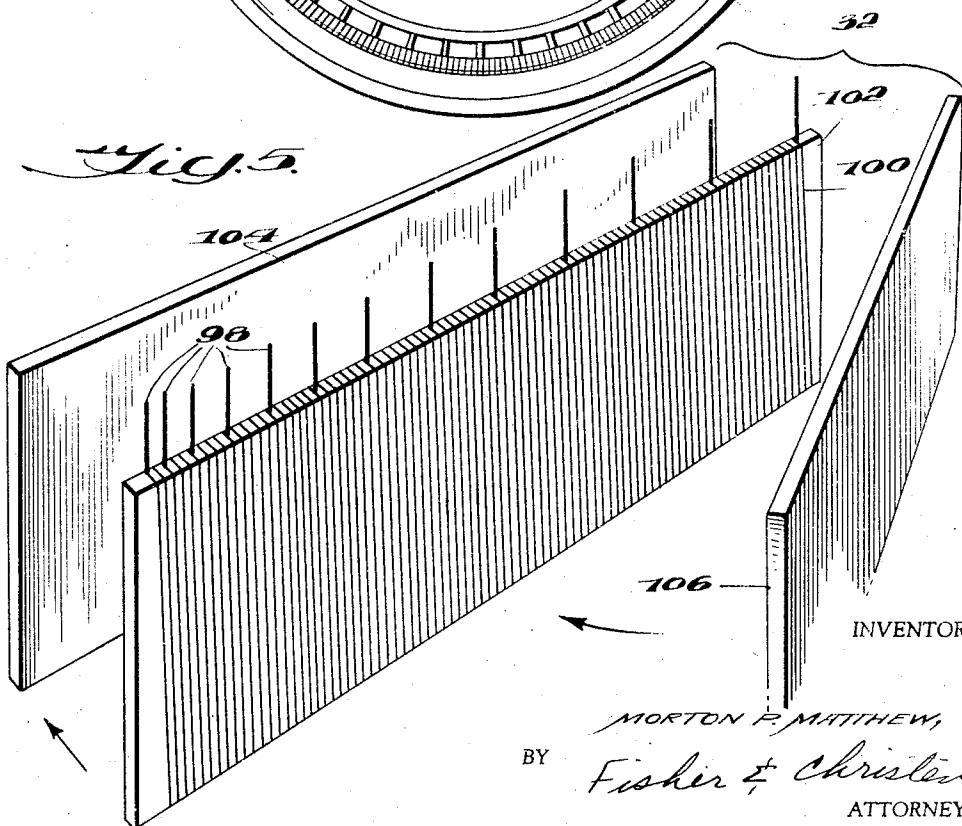


Fig. 5.



BY

MORTON P. MATTHEW,
Fisher & Christen
ATTORNEY

April 15, 1958

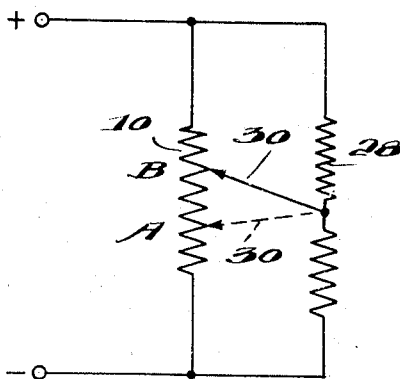
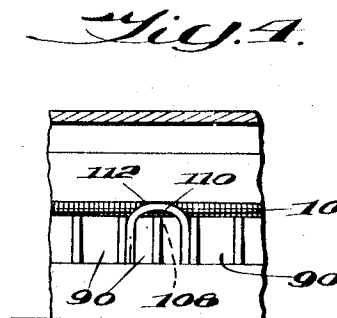
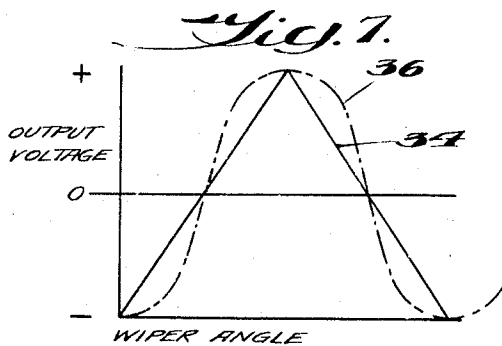
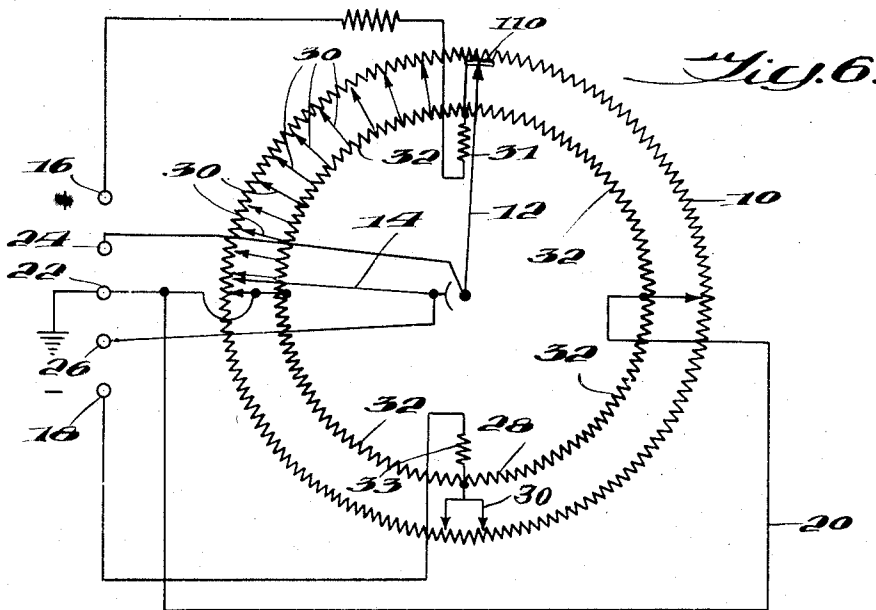
M. P. MATTHEW

2,831,095

VARIABLE FUNCTION VOLTAGE DIVIDER

Filed June 22, 1955

3 Sheets-Sheet 3



INVENTOR

MORTON P. MATTHEW,

BY

Fisher & Christen

ATTORNEYS

1

2,831,095

VARIABLE FUNCTION VOLTAGE DIVIDER

Morton P. Matthew, Takoma Park, Md., assignor to
Litton Industries of Maryland, Inc., a corporation of
Maryland

Application June 22, 1955, Serial No. 517,307

7 Claims. (Cl. 201-56)

This invention relates to a voltage divider, and more particularly to a voltage divider in which it is possible to calibrate the output voltage as a function of the movement of the wiper.

In voltage dividers of this type, a number of problems arise. Foremost among these is the necessity of designing an instrument which will be accurate enough for precision work and which, at the same time, will be a simple, sturdy construction which will be economical to manufacture in quantity.

It is to be understood that devices of this type consist of a main voltage dividing resistance contacted by one or more wipers which are movable along the resistance. Provision is made for connecting resistances in shunt with the main resistor so that the output voltage characteristic can be varied by a changing of the value of the resistance in shunt. The disadvantages of the prior art devices arose particularly in the complexity of the arrangements for variably shunting the primary resistance with the secondary resistances.

It is an object of this invention to eliminate that disadvantage by providing a very simply constructed tap which connects a fixed secondary resistance across a portion of the primary resistance in such a manner that the points of connection can be varied.

It is another object of the invention to provide a new circuit for voltage dividers of this type which eliminates the necessity of bonding a secondary resistance to the primary resistance.

It is yet another object of the invention to provide potentiometers wherein fixed secondary resistors are coupled to a primary resistor through adjustable taps to thereby provide means for adjusting the impedance of the potentiometer to correspond to a desired function.

These and other objects of the invention will become more readily apparent from the following detailed description of the invention taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a top plan view of the voltage divider with the cover removed;

Fig. 2 is a cross-sectional view taken along lines 2-2 of Fig. 3;

Fig. 3 is a cross-sectional view taken along lines 3-3 of Fig. 2;

Fig. 4 is a fragmentary view, in elevation, of one structure which may be utilized for bridging the ends of the main resistance element.

Fig. 5 is an exploded view of a secondary resistance element;

Fig. 6 is a circuit diagram showing one application of the invention;

Fig. 7 is a curve illustrating an application of the invention; and

Fig. 8 is a circuit diagram illustrating the electrical theory of the circuit of Fig. 6.

The invention relates to voltage dividers which are sometimes referred to as variable function potentiometers. It is the purpose of devices of this type to obtain an

2

output voltage which is a precise function of the position of the wiper with respect to the primary voltage dividing resistance. While various regular or irregular functions may be applied, a common voltage divider is designed to have an output voltage based on the sine-cosine relationship. Figs. 6, 7 and 8 illustrate how this is accomplished in the present invention.

The principal element of the voltage divider is a primary resistance 10 which is contacted by wipers 12 and 14. In this example, the primary resistance 10 forms a continuous circle which is connected at diametrically opposite points, through members 30 and 110 to be described, to a source of potential connected to terminals 16 and 18. Ninety degrees around the circle from the points of application of the potential, a conductor 20 is connected to diametrically opposite points through taps 30 and then to ground through terminal 22 in order to assure a uniformity of the two points of zero potential.

The wipers are connected to terminals 24 and 26 from which they can be connected into a circuit in the desired manner.

A secondary resistance 28 is connected to a plurality of taps 30 which adjustably engage the primary resistance 10 in an electrically conducting relation. As will be demonstrated with reference to the preferred embodiment of the invention, the secondary resistance 28 is normally composed of at least four resistance units 32, one positioned in each quadrant of the circle.

Fig. 7 illustrates the principle of the construction of the invention. Assuming that the primary resistance 10 is substantially uniform, the output voltage characteristic, as a function of the wiper angle, would be as shown by the curve 34. In other words, the voltage changes linearly with the change in the wiper angle. By careful selection of the values of the secondary resistances and adjustment of the taps 30 on the primary resistance, the output voltage characteristic can be altered to the sinusoidally shaped curve 36 shown in broken lines.

Fig. 8 illustrates the manner in which the output voltage characteristic is varied by a movement of taps 30. If the tap 30 in Fig. 8 is moved from point A to point B, the net resistance below the tap will increase, and that above the tap will decrease, thereby raising the voltage at the tap. However, A is now below the tap, and therefore at a lower voltage than point B, even lower, in fact than A was before moving the tap. In other words, moving a tap in the direction of higher voltage on the primary resistance has the effect of lowering the voltage of a point on said resistance in this region, and vice versa.

As shown in Fig. 6, the taps 30 break up the secondary resistance elements into approximately $12\frac{1}{2}$ segments. The approximate output voltage characteristic desired will be attained by proper selection of secondary resistance segments between taps. In this case, where a sinusoidal output is desired, there will be high resistance segments in the region where the slope of the output curve is high, and low resistance segments where the slope is low. At the peaks, where the slope is zero, there will be zero resistance segments between taps, that is, two taps electrically connected together. At one peak, however, the two connected taps are replaced by bridge 110, to be described.

Low resistances 31 and 33 may be added to give truer approximations to the average sine function values in the regions spanned by the connected taps and the bridge, respectively.

The manner in which the circuitry of Fig. 6 is embodied into a practical construction is shown in Figs. 1-5.

A molded plastic housing or casing 40 houses all of the elements and is closed by the metallic circular top

42, having a downwardly depending annular flange 44. The top is retained in position by set screws 46 which are threaded into the plastic material.

The casing 40 has an internal angular shoulder 48 on which rests a circular core or mandrel 50 which has the primary resistance 10 wound thereon. Instead of using a circular wire core as shown, it is also possible to use a wire wound shaped resistance card bent into a circle and seated on shoulder 48. Normally the diameter of the resistance wire lies in a range of $\frac{1}{10000}$ to $\frac{1}{1000}$.

The wipers 12 and 14 are mounted in a manner to be described below to a spindle 52. The other ends of the wipers terminate in small brushes 54 and 56, respectively, which electrically contact a primary resistance 10.

Downwardly depending from the wipers are contacts 58 and 60 which engage slip rings 62 and 64, respectively. Slip ring 64 is connected by a conductor 66 to terminal post 26. In a similar manner, the slip ring 62 is connected to the terminal post 24.

The spindle 52 is rotatably mounted in the casing 40 in any suitable manner. In the example shown, two ball bearings 68 are utilized, with the spindle and bearings being maintained in axial position by a clip 70 at the lower end of the spindle, and a spring washer 72 at the upper end thereof urging the spindle upwardly and urging the bearings toward each other against shoulders in the housing.

The upper end of the spindle is knurled at 74 to fixedly engage wiper mounting disc 76 constructed of insulating material. Each wiper is clamped to the mounting disc 76 by two screws 78 and 80, which threadedly engage a plate 82, having two spaced threaded holes to receive the screws 78 and 80.

The screws 78 and 80 pass through holes in each wiper which are larger than the diameter of the screw shank. The enlarged hole permits the wiper to be pivoted through an angle of a few degrees so that the brushes 54 and 56 of each wiper can be arranged to be exactly 90 degrees apart. To facilitate this rotation, the wipers are formed with a hole 84 having a slot 86. The mounting disc 76 also has a slot 88 aligned with the slot 86. The two slots 86 and 88 receive a screw driver which, when rotated, causes the pivoting of the wiper 12 with respect to the mounting disc 76 when the screws are not fully tight.

Immediately below the primary resistance are a plurality of pockets 90. These pockets receive a small U-shaped tap 30, as best shown in Fig. 2. The tap has a contact end portion 94 which conductively engages the main resistance 10. The other end portion 96 is connected by a conductor 98 to the resistance element 32.

Normally, the tap 30 has its end portions 94 and 96 spread farther apart than shown in Fig. 2. Thus when the tap is forced into the pocket 90, the resilience of the metal causes the contacting end 94 to be sprung against the primary resistance 10.

Fig. 1 shows clearly that the width of the tap 30 is considerably less than the width of the pocket 90, so that the tap can be shifted approximately 5 degrees along the resistance 10 while maintaining a good electrical contact.

The design of the resistance element 32 is subject to considerable variation. For example, it can be constructed of a plurality of individual resistance elements embedded in the plastic casing 40, or it can be constructed as shown in Fig. 5.

Fig. 5 shows a resistance wire 100 wound around a core 102, with the conductors 98 being welded or soldered to selected points along the length of the wire 100 in order to provide the desired values of resistance segments for the circuit referred to in Fig. 6.

The core is enclosed by the two insulating members 104 and 106 and all three elements are then clamped together by an adhesive or the like.

With reference now to Fig. 4, there is shown one structure which may be utilized for bridging the ends of

the primary resistance winding in the potentiometer of the invention. To appreciate the construction of Fig. 4, it must be understood that the main resistance wire 10 is normally wound on a straight core 50. The core 50 is then bent to the circular form and lodged in the casing 40 as shown. This construction leaves a break in the core and resistance wire occurring at 108, as shown in Figs. 1 and 4. To bridge this gap electrically and mechanically, a U-shaped member 110 is inserted in the slots 90 adjacent the break. The upper portion of the member 110 extends slightly above the line of the resistance wire 10, as indicated at 112. This provides a mechanical bridge to permit the wiper elements 54 and 56 to ride smoothly over the break. As indicated, the member 110 also provides a good electrical connection between the ends of the resistance element 10, and with the wiper.

In a general manner, while there has been disclosed in the above description what is deemed to be the most practical and efficient embodiment of the invention, it should be well understood that the invention is not limited to such embodiment, as there might be changes made in the arrangement, disposition and form of the parts without departing from the principal of the present invention as comprehended within the scope of the accompanying claims.

I claim:

1. A variable function potentiometer comprising: a primary resistance including a core having a fine resistance wire wound thereon; a plurality of fixed secondary resistances connected in series; a plurality of taps, each connected at one end to the junction of two of said secondary resistances, the other end of said taps being adjustably engageable with said primary resistance wire at spaced points along the length thereof; a wiper contacting said primary resistance and moveable along the entire length thereof; and a casing for mounting said primary resistance and having a plurality of pockets adjacent said primary resistance, each of said taps including a U-shaped spring member slightly compressed and set into an associated one of said pockets, one end of said U-shaped member being connected to said secondary resistance and the other end electrically contacting said fine resistance wire wound on said core.

2. In a potentiometer including a resistance element, a tap arrangement comprising an insulating casing for mounting said element and having at least one pocket adjacent said element, an electrical conductor having one end adjustably and resiliently contacting said resistance element, a portion of said conductor being resiliently contained in said pocket, said conductor being shiftable in said pocket to vary the position of contact of said one end with said element whereby an adjustable tap is provided for contacting said resistance element.

3. An adjustable tap for a variable resistance comprising a U-shaped conductor of resilient material, means for mounting said resistance and for forming a pocket adjacent said resistance to receive said conductor, said conductor being compressed into said pocket with one of the arms of the U extending outwardly into contact with said resistance, and said pocket having walls spaced from the plane of said U-shaped conductor to permit the conductor to be shifted in said pocket thereby to vary the point of contact of said conductor on said resistance.

4. A potentiometer comprising: a cylindrical housing member; a circular primary resistance mounted within said housing member, said housing member having a plurality of pockets formed therein adjacent said primary resistance; tap means mounted in said pockets for adjustably engaging said primary resistance at points along the length thereof; a secondary resistance; electrical connectors between said tap means and fixed points along said secondary resistance; and a wiper contacting said primary resistance and moveable along the length thereof.

5

5. A potentiometer comprising: a cylindrical housing member; a primary resistance mounted within said housing member, said primary resistance including a circular core having a relatively fine resistance wire wound thereover; a plurality of adjustable taps mounted on said housing member adjacent said primary resistance and disposed along the length of said primary resistance, each of said taps engaging said primary resistance at substantially a point contact and being adjustable to engage said primary resistance at any point over a predetermined sector of said primary resistance adjacent said tap; a plurality of serially connected secondary resistances mounted within said housing member; conductor means connecting said taps to the junctions of said secondary resistances; and a wiper contacting said primary resistance and moveable along the length thereof.

6. A variable function potentiometer comprising: a cylindrical housing member; a circular primary resistance mounted within said housing member, said resistance including a core with a relatively fine resistance wire wound thereon; a plurality of fixed secondary resistances connected in series, said secondary resistances being mounted

6

within said housing member radially inward of the circle defined by said primary resistance; a plurality of taps each electrically connected at one end to the junction of two of said secondary resistances, the other end of said taps being adjustably engageable with said primary resistance wire at spaced points along the length of said primary resistance; and a wiper contacting said primary resistance and moveable along the entire length thereof.

7. A voltage divider according to claim 6 in which the values of said secondary resistances change from one end of the series to the other, whereby the desired voltage function is caused to be approximated prior to the adjustment of said taps.

References Cited in the file of this patent

UNITED STATES PATENTS

2,662,146	Wilentchick	Dec. 8, 1953
2,662,147	Wilentchick	Dec. 8, 1953
2,662,149	Wilentchick	Dec. 8, 1953
2,676,226	Mucher	Apr. 20, 1954