Sept. 30, 1958 A. P. BOYSEN, JR., ET AL 2,854,542

VIBRATORY SIGNALING DEVICE

Filed May 24, 1955 2 Sheets-Sheet 1

FIG. 1

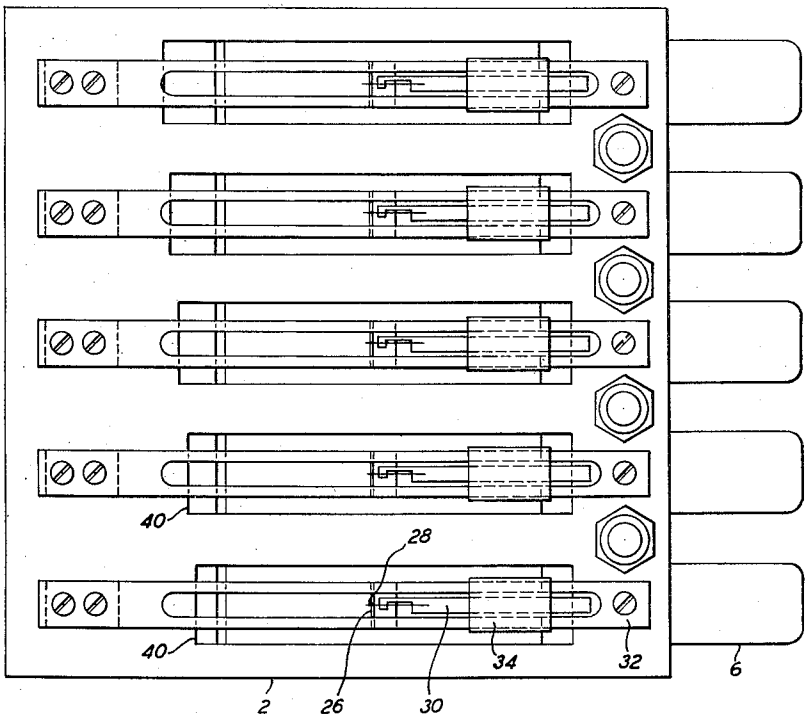
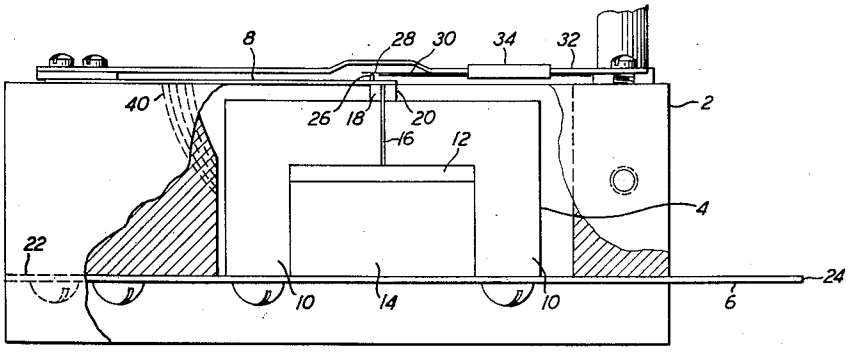


FIG. 2



INVENTORS A. P. BOYSEN, JR.
L. E. KREBS

BY V. P. Priolo

ATTORNEY

Sept. 30, 1958 A. P. BOYSEN, JR., ET AL 2,854,542

VIBRATORY SIGNALING DEVICE

Filed May 24, 1955 2 Sheets-Sheet 2

FIG. 3

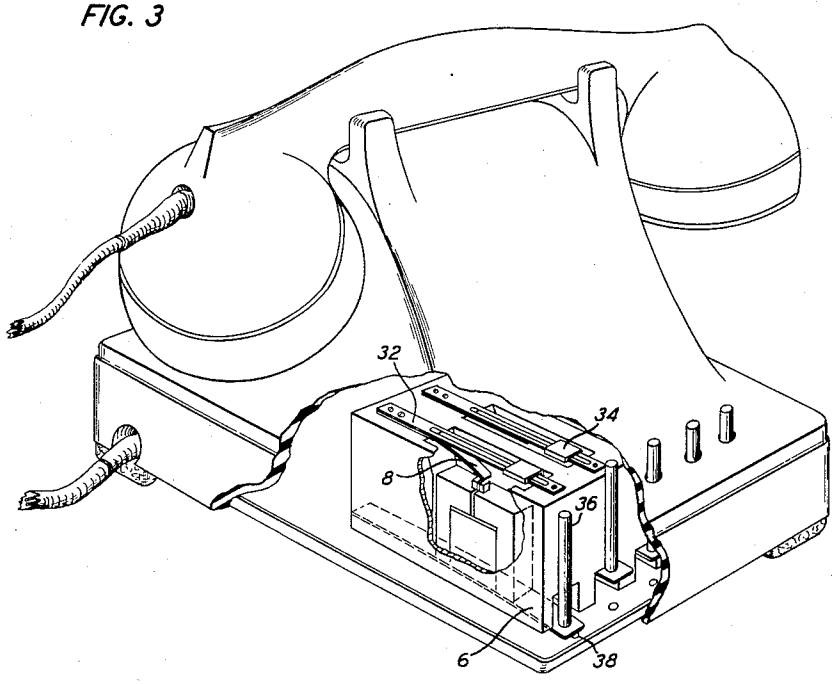
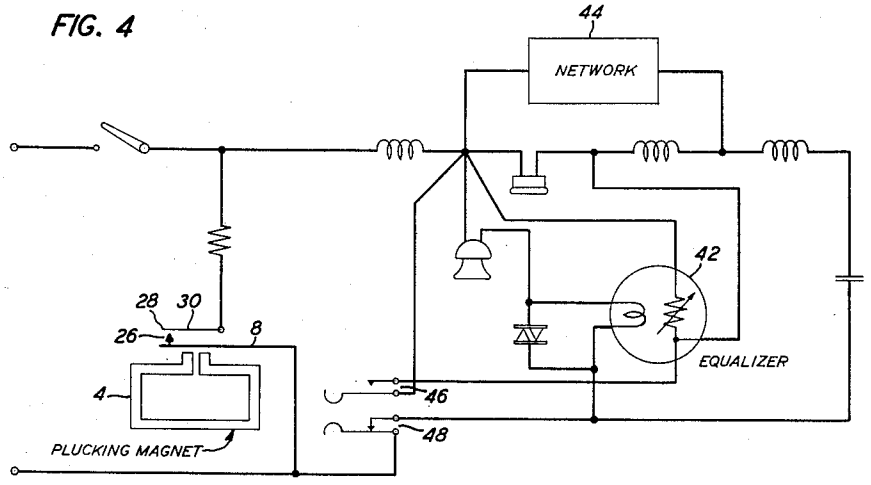


FIG. 4



INVENTORS A. P. BOYSEN, JR.
L. E. KREBS
BY V. P. Priolo
ATTORNEY

United States Patent Office 2,854,542
Patented Sept. 30, 1958

2,854,542

VIBRATORY SIGNALING DEVICE

Albert P. Boysen, Jr., Basking Ridge, and Luther E. Krebs, West Orange, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 24, 1955, Serial No. 510,634

5 Claims. (Cl. 200—87)

This invention relates to vibratory signaling devices, and particularly to devices of the type wherein a flexible mechanical member or reed is set into vibration to generate an electrical signal of characteristic frequency.

Telephone signaling systems have been developed wherein combinations of alternating current of different frequencies are generated at the calling subscriber's subset and sent over the line to the central office to establish the digit code of the called telephone number in the central office register-sender. A system of this kind is that shown in Patent 2,237,742, issued to A. A. Lundstrom on April 8, 1941. To generate the alternating current, subsets have been developed which include a number of vibratory reeds and keys. Each key, when depressed, plucks particular ones of the reeds. Each reed is disposed in a magnetic field and is surrounded by a pickup coil. When any reed is plucked it vibrates at its natural frequency, and produces in its coil an alternating current of the same frequency. A generator of this kind is shown in Patent 2,147,710, issued to R. F. Mallina on February 21, 1939. In a particular embodiment shown in that patent, ten keys and five reeds are provided, each tuned to a different frequency. Each key simultaneously plucks a particular combination of two of the reeds so that ten frequency combinations are available corresponding to the ten digits on a telephone dial.

In utilizing frequency generators of this kind, it has been found that wear of the reeds at the point where they are plucked by an actuationg pawl eventually causes changes in their natural frequencies. Since the central office equipment comprises frequency channels tuned to the frequencies of the reeds in the subset, this necessitates frequent reed adjustment. Various attempts to reduce reed wear have been made. One of these is shown in Patent 2,352,723, issued July 4, 1944, to R. F. Mallina wherein mechanical means hold the reed pretensioned beyond its point of release by a key. However, it is still necessary for a latching member to hold and then slide off the end of the reed.

It is an object of the present invention to provide means for vibrating a flexible mechanical member without producing frictional wear of the member.

A further object is to provide a vibratory signaling device wherein a reed is set into vibration without any wear producing physical contact with the actuating means and wherein the actuating means has no damping effect on the reed after having initiated the vibration.

According to the invention, a flexible ferromagnetic reed is cantilever supported with its free end bridging a small air gap in the flux path of a strong magnet. The magnet is mounted on a cantilever supported leaf spring, the end of the latter capable of being pushed downward by depressing a key. When the key is depressed, the magnet moves downward with the spring and deflects the end of the reed. The reed breaks free when the restoring force in it exceeds the magnetic pull, and vibrates at its natural frequency. The magnet continues downward until it or the key hits a stop. The small air gap assures

that virtually no leakage flux will penetrate the reed after it breaks free of the magnet, so that the reed will vibrate at a constant single frequency. Releasing the key enables the leaf spring to return to rest, the magnet moving up and again attracting the reed to stop its vibration.

The invention may be more clearly understood by reference to the following specification and the accompanying drawings in which:

Fig. 1 is a top view of a preferred embodiment of the invention;

Fig. 2 is a partially sectioned view in front elevation showing the magnet assembly;

Fig. 3 is a partially sectioned view in perspective of a telephone set showing the invention assembled therein; and

Fig. 4 is a circuit schematic of a telephone set including the invention for tone dialing.

Referring now to the accompanying drawings, **2** is a mounting block of non-magnetic material such as brass within which the magnet assembly **4** is housed and to which the cantilever supported leaf spring **6** and the cantilever supported reed **8** are affixed. The magnet assembly **4** comprises a U-shaped soft magnetic element **10** the legs of which are secured to the leaf spring **6**, a spacer **12** of non-magnetic material such as brass, and a block **14** of magnetic material such as Alnico V securely positioned between the legs of the U-shaped element **10** and the spacer **12**. A narrow gap **16** cut through the center of the U-shaped element defines the pole-pieces **18** and **20**. Pole-pieces **18** and **20** project above the U-shaped element.

The flat leaf spring **6**, made of a material such as Phosphor bronze, is supported horizontally in the mounting block **2**, secured at one end **22** and free to be deflected downward at its other end **24**. The reed **8**, made of a magnetic mtaerial, is supported horizontally in the mounting block **2** parallel to the leaf spring **6** and the U-shaped element of the magnet assembly. It is secured at one end and free to vibrate at the other end which bridges the air gap **16** and is held magnetically by pole-pieces **18** and **20**. The vibratory end has a contact **26** which, when the reed vibrates, closes to contact **28** affixed, as by soldering, to contact support member **30**. Contact **28** may be in the form of a wire. Contact support member **30** is free at the end which supports contact **28** and secured at the other end to support member **42** by means of an insulating spacer block **34**.

In the embodiment shown in Figs. 1 and 2 reed **8** is in contact with pole-pieces **18** and **20** when bridging gap **16**. While this arrangement has been found to be satisfactory, frictional wear may be further minimized by providing a thin spacer of relatively soft non-magnetic material between reed **8** and pole-pieces **18** and **20**.

When the leaf spring **6** is depressed, as by means of the key **36** (Fig. 3), the magnet is pushed down and pulls the reed **8** with it. When the restoring force set up in the reed exceeds the magnetic pull, the reed breaks free and vibrates to make and break contacts **26** and **28** at the natural frequency of vibration of the reed. The magnet continues to move downward until the spring **6** hits the stop **38**. When key **36** is released spring **6** returns to its rest position and reed **8** is reengaged by the magnet pole-pieces **18** and **20**. As shown in Figs. 1 and 2 the free portion of reed **8**, as determined by the cut **40** in block **2**, establishes the reed's natural frequency of vibration.

As shown in Figs. 1, 3 and 4, the invention may be used to advantage in key-operated frequency tone signaling telephone systems. In the embodiment shown in Figs. 1 and 3 five magnetic plucking units are assembled in a single block **2** and each unit is associated with an individual key **36**. Ten keys may be provided and assembled

in such manner that each key will simultaneously pluck a particular combination of two of the reeds. This can be accomplished by the use of a suitable mechanical linkage, whereby the depression of a key produces simultaneous motion of two of the plucking magnets, as taught in the art referred to hereinbefore. Ten frequency combinations, corresponding to the ten digits on a telephone dial, will thus be made available.

The schematic diagram in Fig. 4 shows a conventional telephone set equipped with the invention for key-operated tone dialing. The set includes an equalizer 42, which maintains substantially constant signal level at the receiver regardless of differences in lengths of subscriber loops and limits the battery supply current through the transmitter, and an anti-sidetone network 44. On hearing dial tone the subscriber depresses a key 36 corresponding to the first digit to be dialed. The movement of the key downward plucks the reed or reeds associated with the key. The ssytem may be so arranged that the movement of the key downward will also successively close a first contact 46 which short-circuits the reeciver to prevent clicks when the set is removed from the line, and open a second contact 48 which removes the set from the line.

The use of a small air gap and the fact that the magnet is removed from proximity to the reed when the reed is released makes damping of the reed motion by the magnetic field negligible. This results in the production of a very nearly pure resonant frequency tone. Since there is no wear on the reed, uniformity of reed vibration is achieved and the frequency remains the same in spite of repeated operation. The reed is plucked identically no matter how fast or how slow the subscriber depresses the key.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A vibratory signaling device comprising a mounting member having an aperture, a flexible, magnetic, cantilever reed secured to said mounting member, the free portion of said reed extending over said aperture, a flexible cantilever spring member secured to said mounting member, a magnet disposed in said aperture between said reed and said spring member and mounted on the free portion of said spring member, said magnet comprising a C-shaped member and a pair of pole tips, said pole tips projecting from said member and disposed between said member and said reed, said pole tips defining a gap therebetween, the free end of said reed bridging said gap to be held magnetically by said pole tips, a contact supporting member secured to said mounting member, a first contact element affixed to the free end of said reed, a second contact element affixed to said contact supporting member, said second contact element being adapted to engage said first contact element, means for displacing said spring member beyond the position at which said reed is suddenly released from said magnet, said sudden release causing said reed to vibrate and said first and second contact elements to engage and separate at the natural frequency of said reed, the natural frequency of said reed being determined by the free portion thereof as determined by the dimensions of said aperture.

2. A vibratory signaling device comprising a mounting block having a plurality of spaced apertures, a plurality of flexible cantilever spring members secured to said mounting block in such manner that the free portion of each of said spring members extends into an individual one of said apertures, a plurality of flexible magnetic cantilever reeds secured to said mounting block in such manner that the free portion of each of said reeds extends over an individual one of said apertures, said reeds being substantially parallel to said corresponding spring members,

an individual magnet disposed in each of said apertures between corresponding reed and spring members and mounted on the free portion of its related spring member, said magnet comprising a C-shaped member and a pair of pole tips, said pole tips projecting from said member and disposed between said member and its related reed, said pole tips defining a gap therebetween, the free end of its related reed bridging said gap to be held magnetically by said pole tips, a separate contact supporting member secured to said mounting member substantially opposite each of said reeds, a first contact element affixed to the free end of each of said reeds, a second contact element affixed to each of said contact supporting members, each of said second contact elements being adapted to engage its corresponding first contact element, means for displacing each of said spring members beyond the position at which its related reed is suddenly released from its magnet, said sudden release causing said reed to vibrate and said first and second contact elements related thereto to engage and separate at the natural frequency of said reed, the natural frequency of each of said reeds being determined by the free portion thereof as determined by the dimensions of the aperture related thereto.

3. A vibratory signaling device in accordance with claim 2 wherein said spring member displacing means is a manually operable key member.

4. A vibratory signaling device comprising a mounting block having a plurality of spaced apertures, a plurality of flexible, magnetic cantilever reeds secured to said mounting block, the free portion of each of said reeds extending over a separate one of said apertures, an individual magnet disposed in each of said apertures between one of said reeds and a supporting spring member secured at one end to said mounting block and free at its other end to be deflected downward, said magnet being secured to the free portion of said spring member and disposed in such manner as to hold the free end of its related reed magnetically, said magnet comprising a C-shaped member and a pair of pole tips, said pole tips projecting from said member and disposed between said member and its related reed, said pole tips defining a gap therebetween, the free end of its related reed bridging said gap to be held magnetically by said pole tips, a separate contact supporting member secured to said mounting member substantially opposite each of said reeds, a first contact element affixed to the free end of each of said reeds, a second contact element affixed to each of said contact supporting members, each of said second contact elements being adapted to engage its corresponding first contact element, means for deflecting each of said spring members beyond the position at which its related reed is suddenly released from its magnet, said sudden release causing said reed to vibrate and said first and second contact elements related thereto to engage and separate at the natural frequency of said reed, the natural frequency of each of said reeds being determined by the free portion thereof as determined by the dimensions of the aperture related thereto.

5. A vibratory signaling device in accordance with claim 4 wherein said spring member deflecting means is a manually operable key member.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 21,038	Leins	Mar. 28, 1939
1,061,919	Miller	May 13 ,1913
1,254,658	Clausen	Jan. 29, 1918
1,348,842	Barlow	Aug. 10, 1920
1,643,270	Greiner	Sept. 20, 1927
2,269,242	Bakke	Jan. 6, 1942
2,289,830	Ellwood	July 14, 1942
2,618,717	Westin	Nov. 18, 1952
2,770,697	Kellett	Nov. 13, 1956