

April 10, 1951

F. L. DODD

2,548,710

CHIME

Filed Aug. 18, 1947

2 Sheets-Sheet 1

FIG. 1.

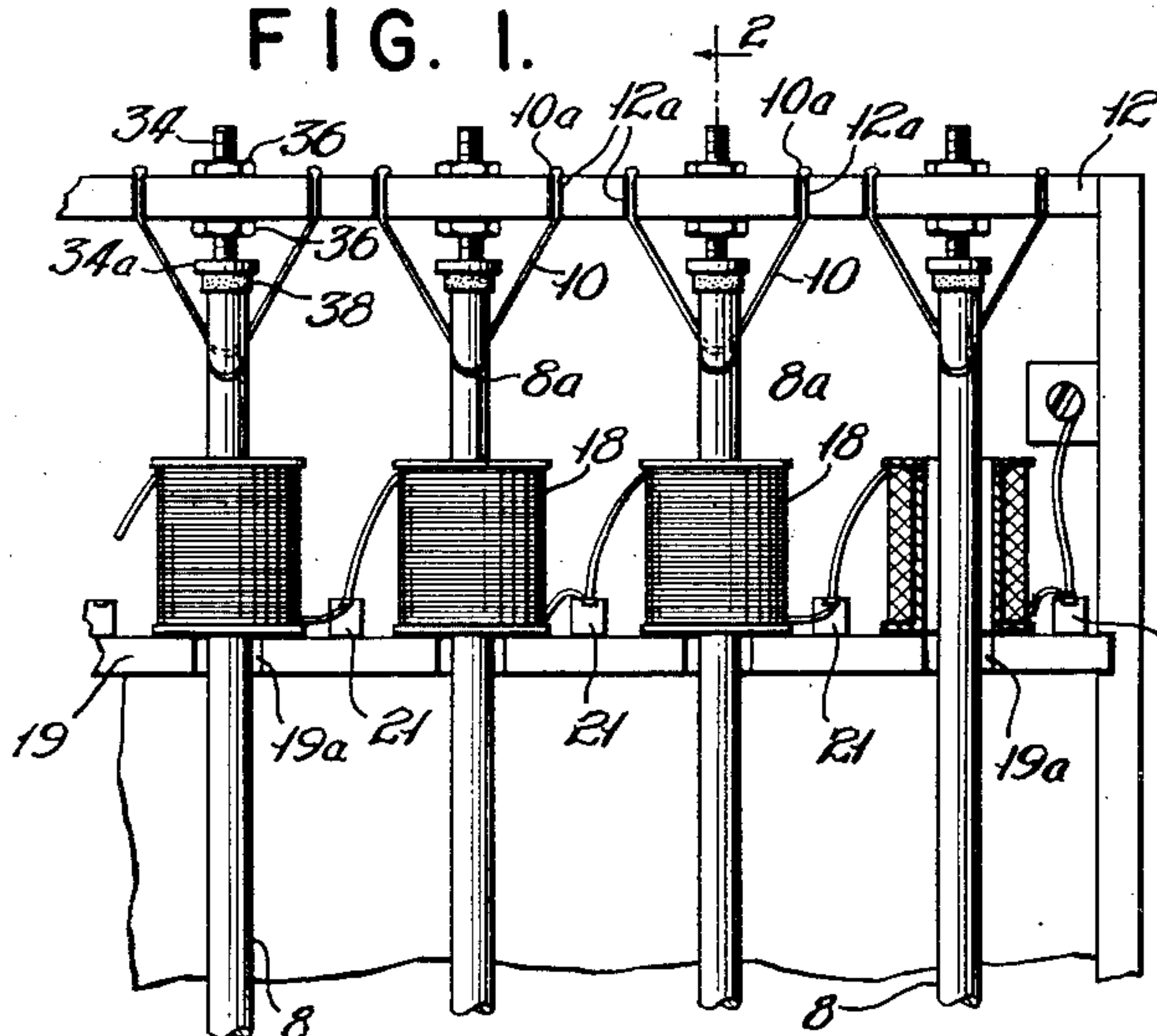


FIG. 2.

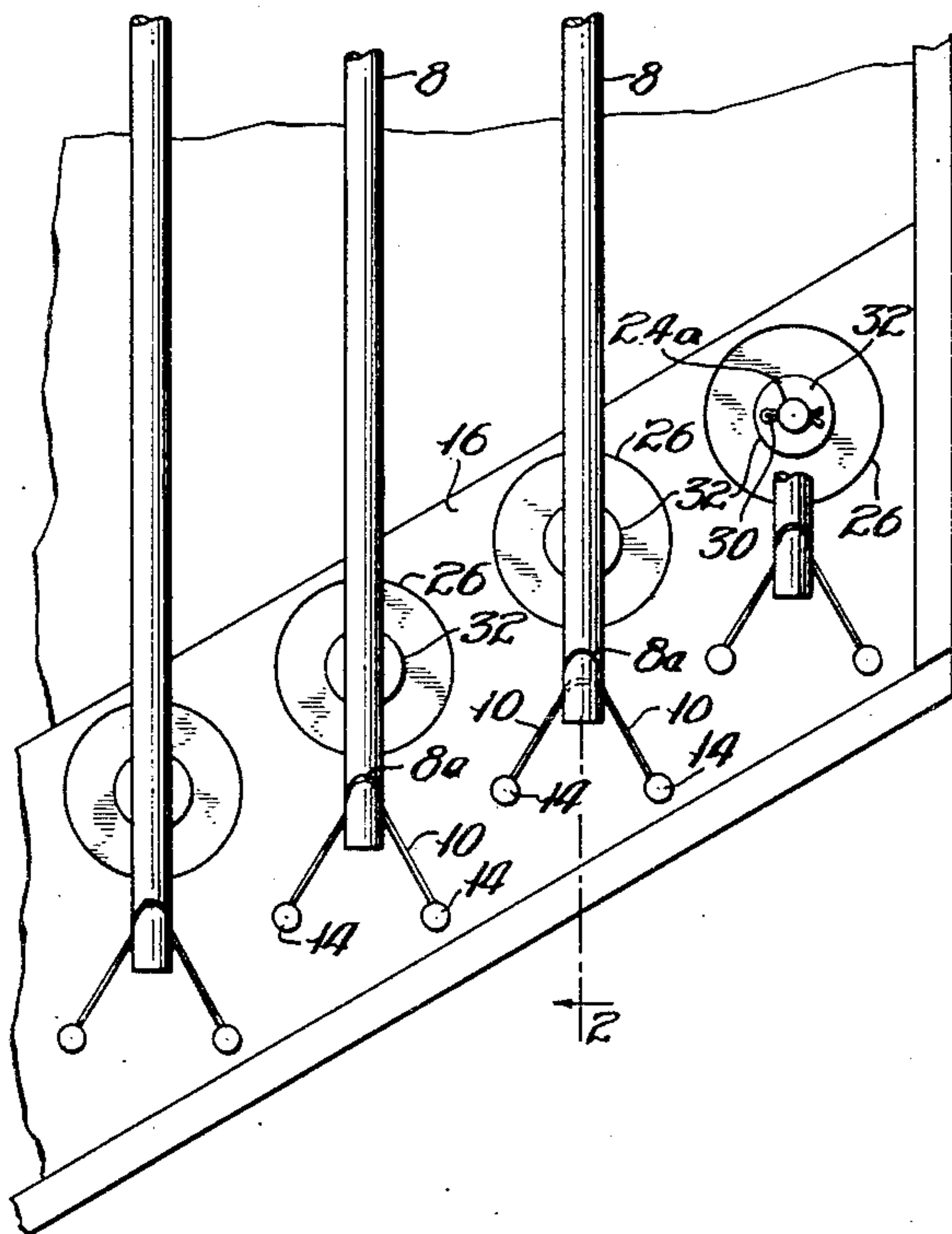
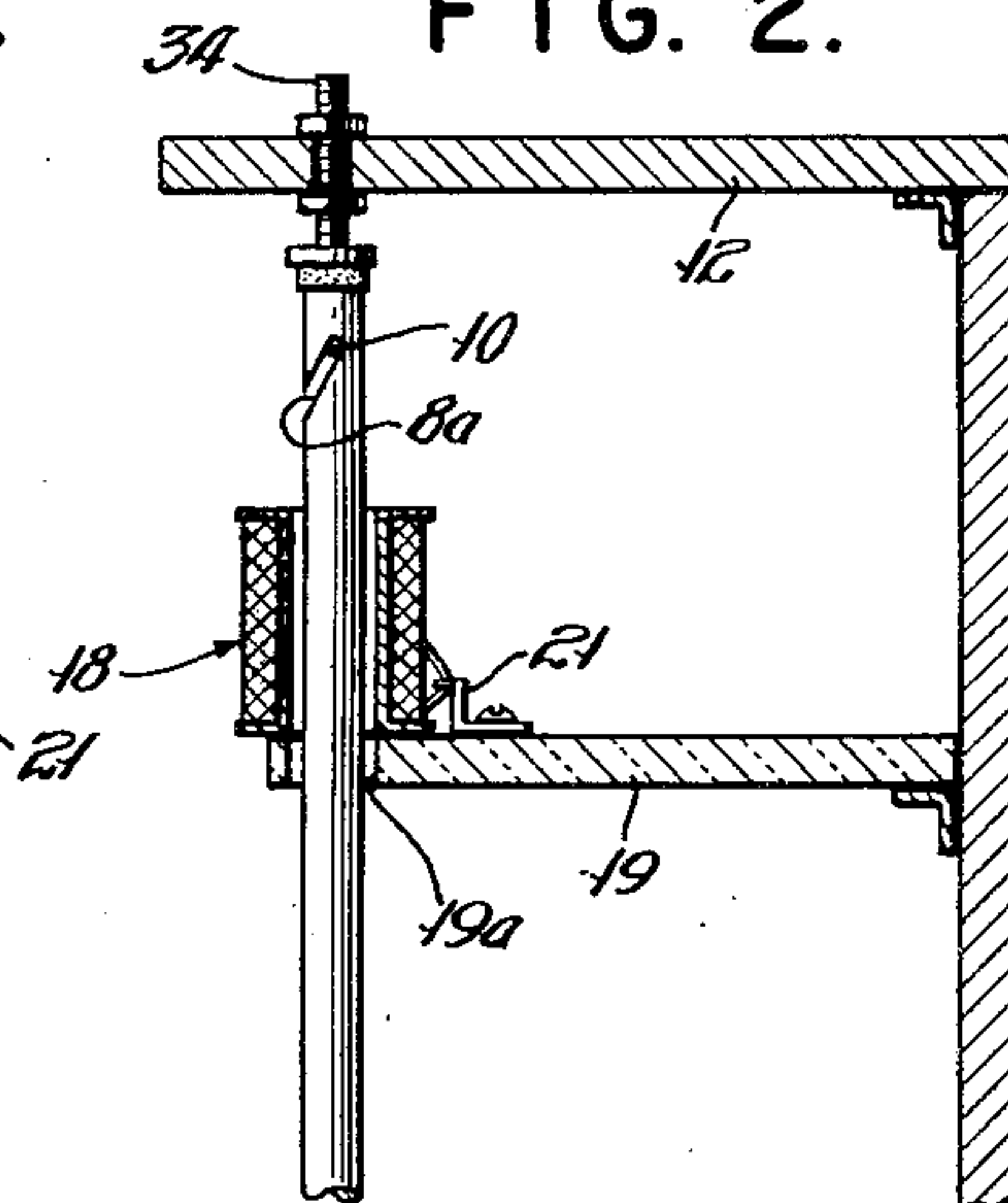
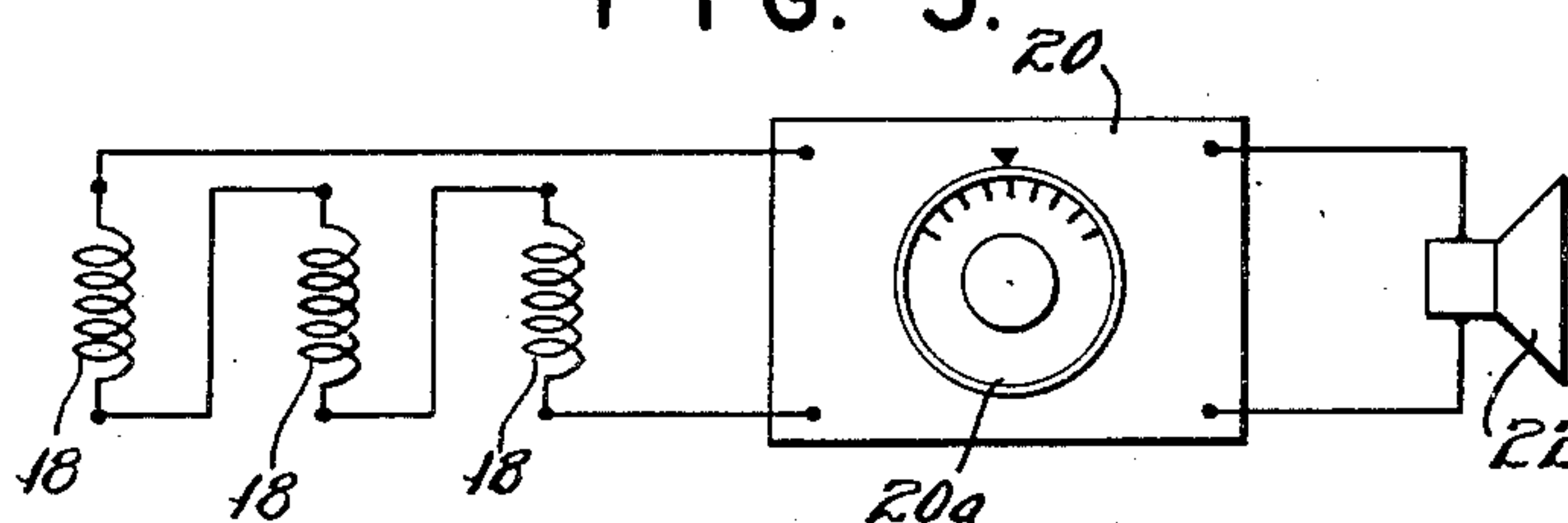
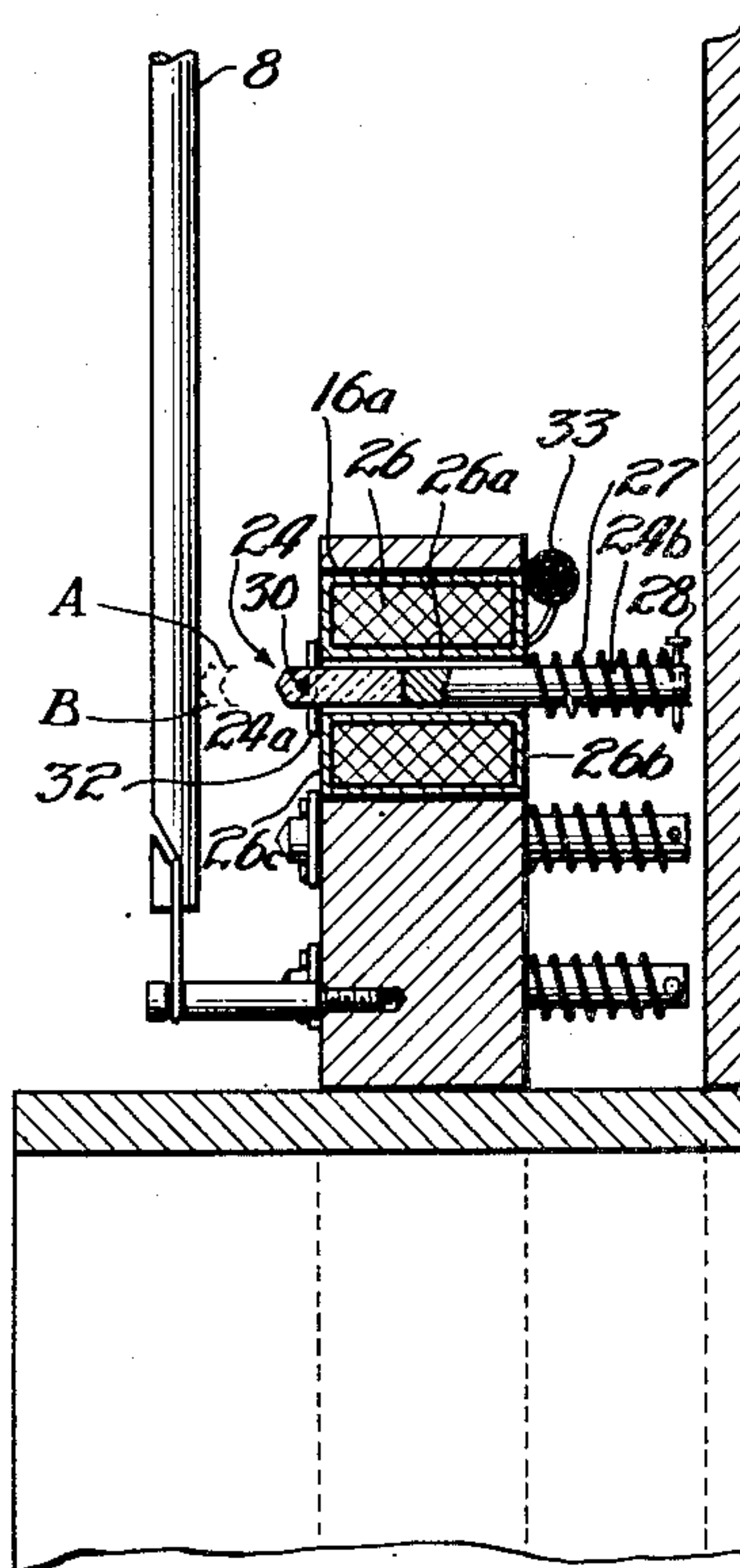


FIG. 3.



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FIG. 4.

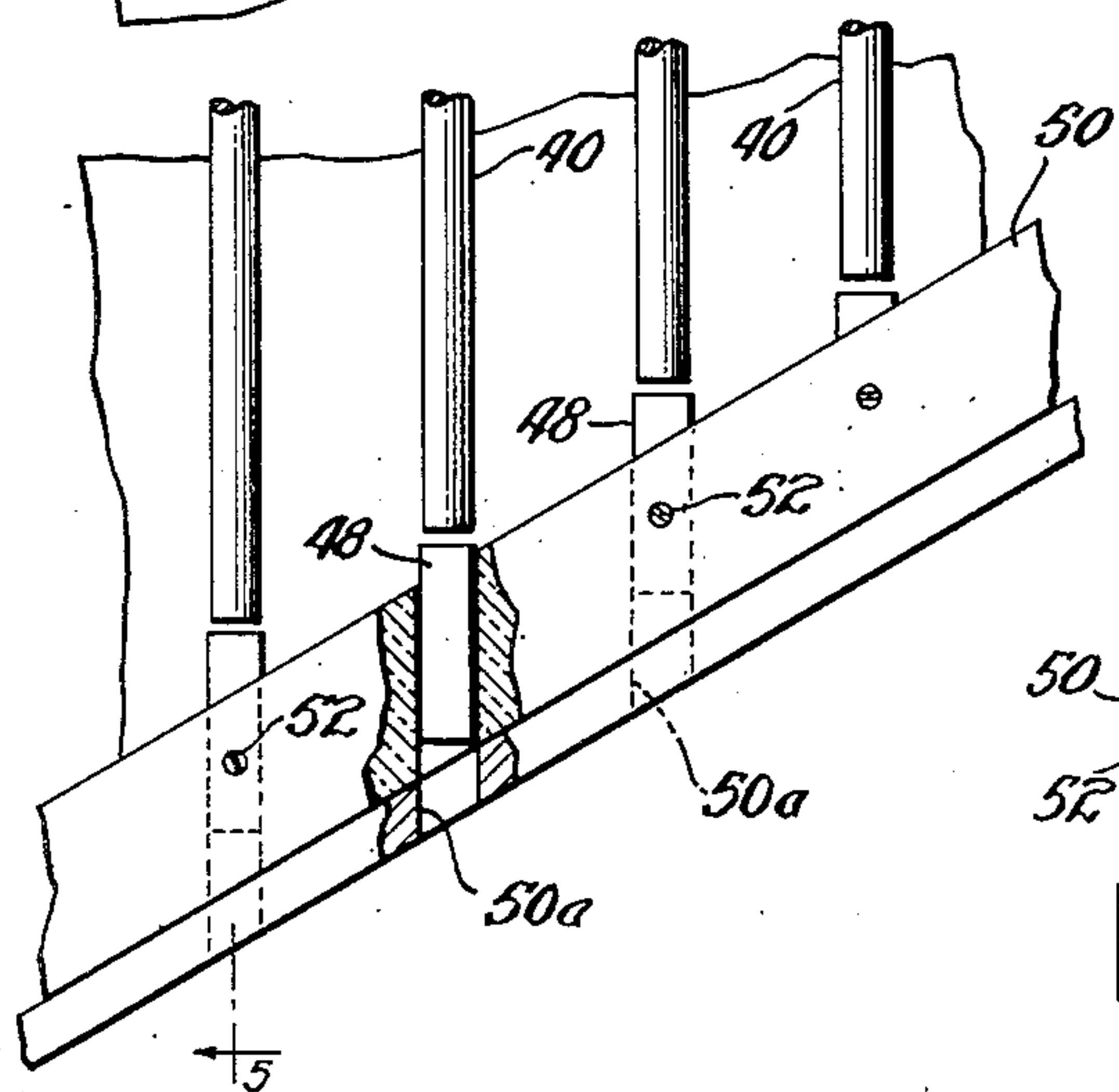
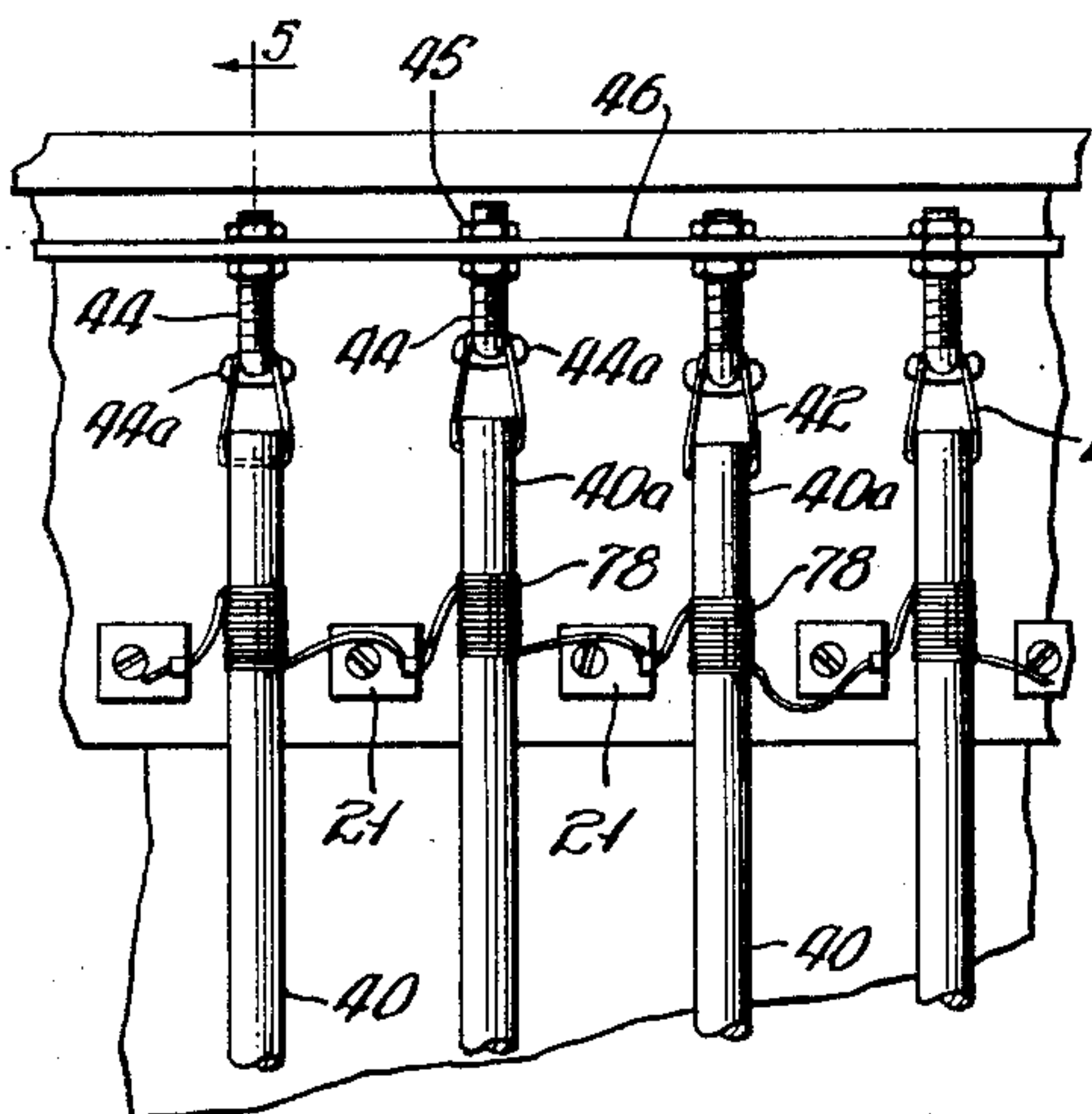


FIG. 5.

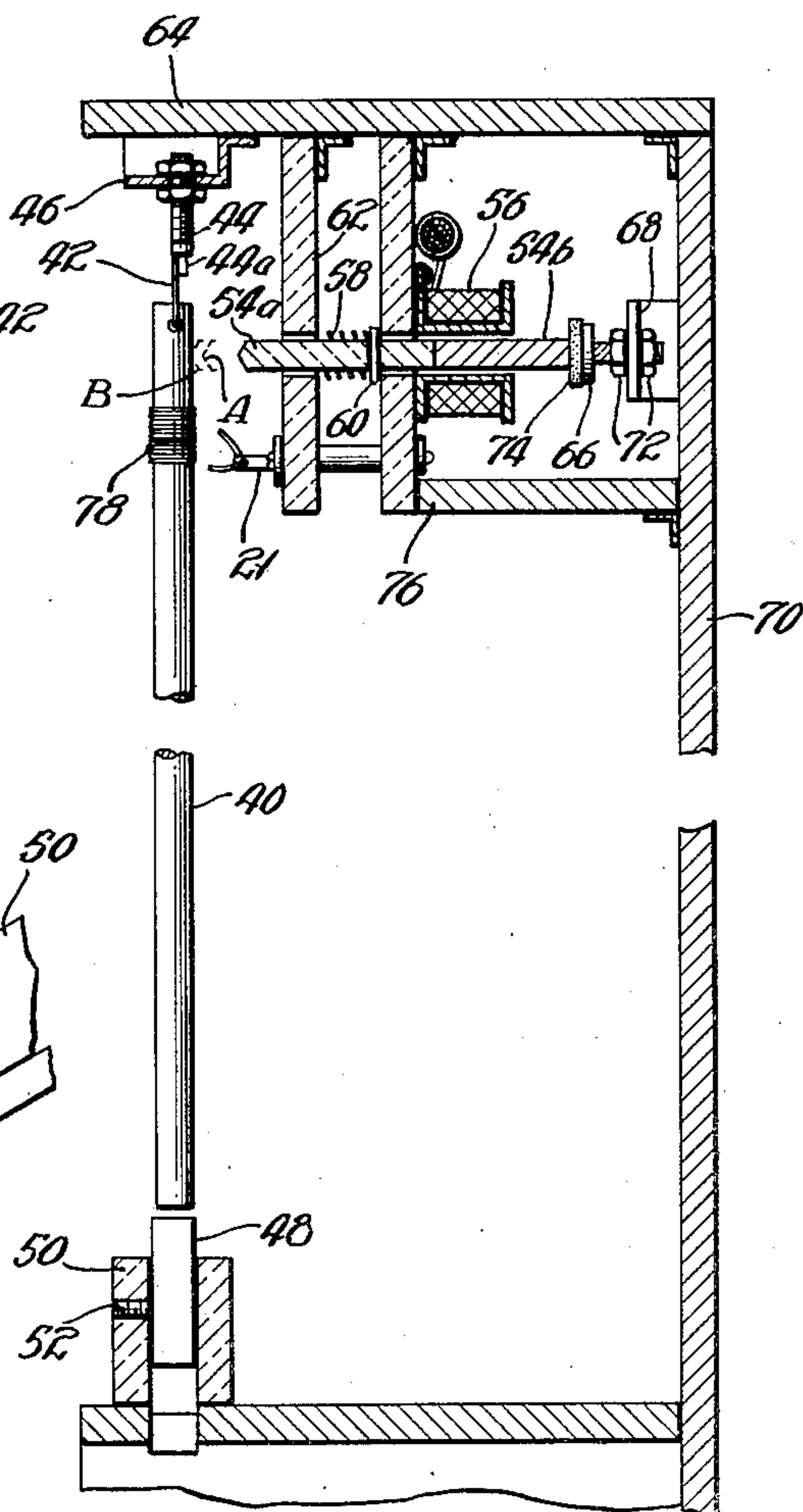


FIG. 6.

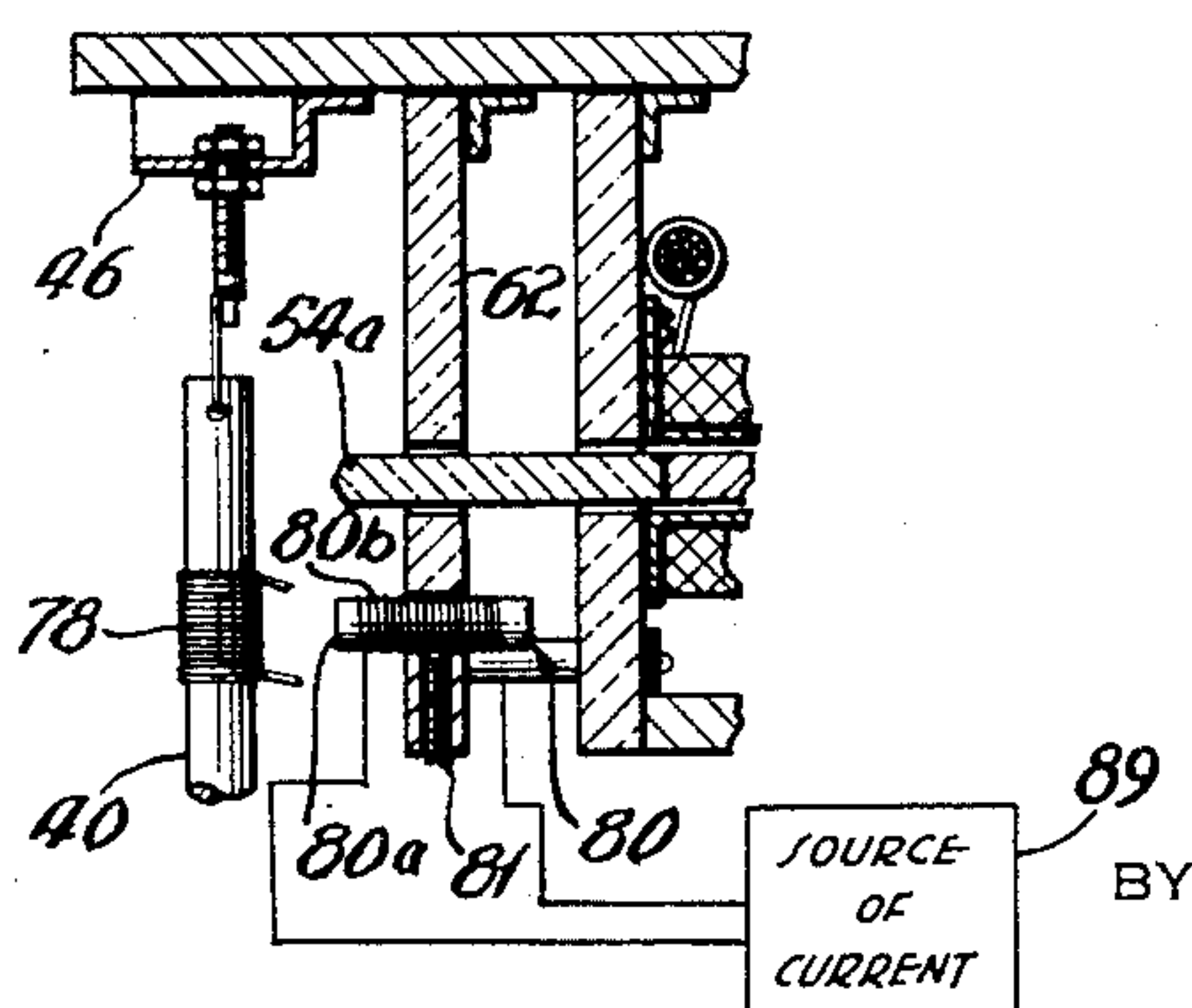


FIG. 7.

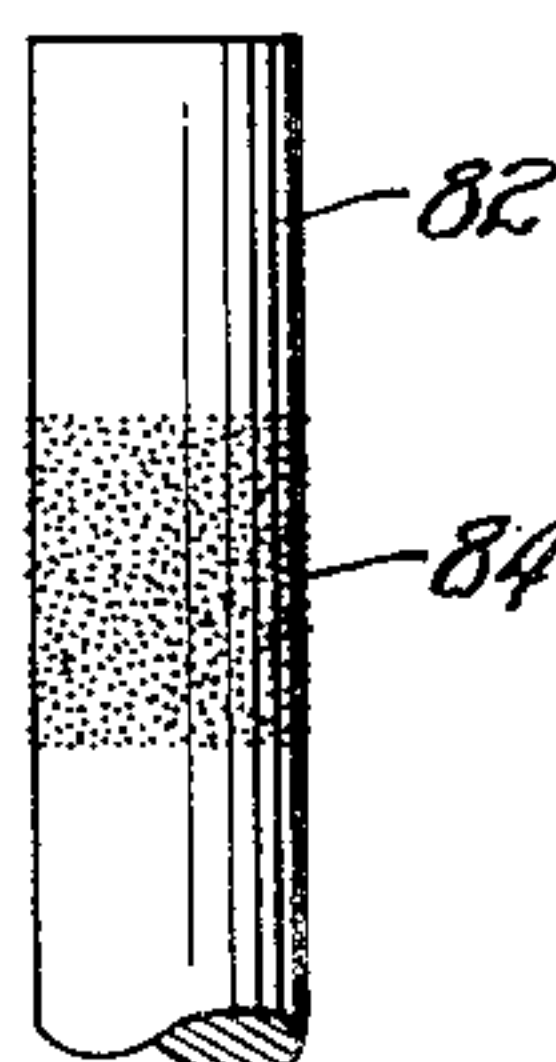
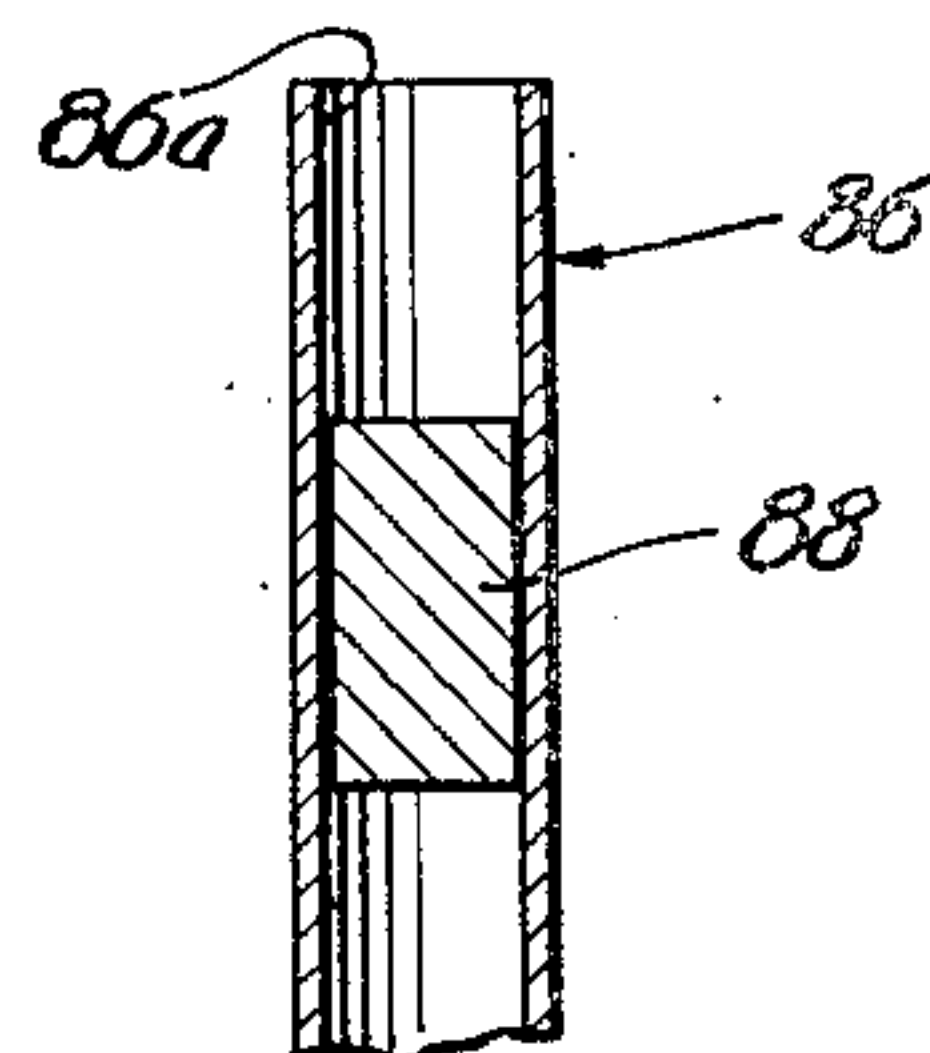


FIG. 8.



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## UNITED STATES PATENT OFFICE

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CHIME

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10 Claims. (Cl. 84—1.04)

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This invention relates to chimes, particularly electronic chimes, i. e., musical instruments wherein the oscillations of tuned, freely supported vibrating elements are translated into electrical signals amplified, and converted into sound waves.

It is among the objects of the invention to provide a chime instrument which is susceptible of economical production, which is compact and easily installed, and which is capable of producing harmonious tones. A more particular object is that of providing advantageous means for supporting the vibratile elements of such instrument and limiting the amplitude and duration of the oscillations thereof. Another special object is that of providing in an electronic chime means allowing use of non-magnetic material in the tone rods thereof. Other objects will be in part apparent and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which are shown various possible embodiments of this invention,

Figure 1 is a fragmentary front elevation of a chime instrument embodying features of the invention;

Figure 2 is a section along line 2—2 of Figure 1;

Figure 3 is a schematic representation of the audio-frequency electrical system of the instrument shown in Figures 1 and 2;

Figure 4 is a fragmentary front elevation of a chime instrument constituting an alternative embodiment of features of the invention.

Figure 5 is a section along line 5—5 of Figure 4;

Figure 6 is a fragmentary vertical section of another instrument embodying other features of the invention; and

Figures 7 and 8 are a fragmentary plan and section, respectively, of two alternative types of tone rod embodying features of the invention.

The instrument shown in Figures 1 and 2 includes a plurality of cylindrical steel rods or tuned members 8, each of which is supported at either end by a flexible and elastic filament 10 engaged in a diagonal slot 8a near the end of the rod. The ends of the filaments 10 which support the upper ends of the rods pass through slots 12a in a transverse structural member 12 of the instru-

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ment and are secured, as by knotting, at 10a, on the upper side of member 12. The filaments 10 at the lower ends of the rods are secured at either end to studs 14 projecting forwardly from a bar 16 which extends transversely of the instrument. Bar 16 is inclined to allow for varying lengths of the rods 8, the lengths being tuned to the frequencies of a tempered chromatic scale. Surrounding each of the rods 8 is a helically wound pick-up coil 18, the inside diameter of the coil being great enough to receive the rod 8 with sufficient spacing therefrom to allow the rod to vibrate freely without contacting the coil. Coils 18 may suitably be secured on a transversely extending shelf 19, the shelf being provided with circular holes 19a for accommodating the rods 8, holes 19a suitably being of diameter approximately equal to the inside diameter of coils 18. Pickup coils 18 are connected in series across the input of an audio frequency amplifier 20, as shown in Figure 3; soldering lugs 21 mounted on shelf 19 between coils 18 facilitate connections between the coils. The output of amplifier 20 is connected in turn to a loud-speaker 22 (Figure 3). Rods 8 are permanently magnetized; as a rod vibrates either longitudinally or transversely the magnetic lines of force set up by it cut through the turns of its pick-up coil 18, inducing in the coil electrical currents which vary in conformity to the mode of vibration of the rod. These electrical signals are amplified in the amplifier 20 and converted into sound waves by the loud-speaker 22. Thus, means is provided for translating the vibrations of the tuned members or rods 8 into sound waves. The amplifier 20 is provided with a volume control 20a so that the amplitude of the audio output of the loud-speaker 22 may be adjusted as desired.

As shown in Figures 1 and 2, coils 18 are mounted a short distance from the upper end of rods 8. The distance is not critical; however, if coils 18 are mounted too low on the rods the signals induced in the coils will suffer a diminution of amplitude because the magnetic flux surrounding the rods is concentrated near their ends; mounting of coils 18 too high on rods 8 will emphasize higher frequency partials in the mode of vibration of the rods, resulting in a high, tinny output note.

The rods are excited by means of a hammer 24 mounted adjacent each of the rods and actuated by a solenoid 26. Each hammer 24 is comprised of a non-magnetic head portion 24a (Figure 2), suitably of plastic material, and a shank portion 24b of magnetic material, suitably soft steel.



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Hammer 24 is slidably received in the bore 26a of solenoid 26 and is urged rearwardly by a spring 27 compressed between the rear side 26b of solenoid 26 and a pin 28 projecting through the rear end of hammer 24. The rearward movement of hammer 24 is limited by a pin 30 which projects through hammer 24 near the head thereof and a felt washer 32 around hammer 24 and resting against the front end 26c of solenoid 26. Energization of solenoid 26 urges hammer 24 forwardly against the resistance of spring 27 into that position where the magnetic shank 24b is centered with respect to solenoid 26, as indicated by dotted line A in Figure 2. Since hammer 24 moves toward this central position with considerable velocity, it "overshoots" to reach the position indicated by dotted line B, where it strikes rod 8, sets it into oscillation, and instantly recedes toward the central position. Thus, no matter how long the solenoid 26 is energized, hammer 24 only "flicks" rod 8, rather than continuing to bear against it and damping its oscillation. When solenoid 26 is de-energized, spring 27 forces hammer 24 back to the position shown in Figure 2, with felt washer 32 noiselessly cushioning its stop.

Solenoids 26 are mounted in holes 16a in bar 16 (Figure 2) so that the solenoid is completely laterally enclosed by bar 16. This shielding reduces the magnetic radiation of solenoids 26 and prevents their radiation of noise to pickup coils 18.

Solenoids 26 are connected by multi-conductor cable 33 to a source of electrical current through a standard musical keyboard so that depression of one of the keys on the keyboard closes a switch which connects the source of electrical current with the solenoid 26 opposite the rod 8 corresponding to the key depressed; thus hammers 24 may be selectively actuated to strike the rods 8 by depression of keys on the keyboard and any desired tune played in the customary manner.

It has been found that the manner of mounting rods 8 as shown in Figures 1 and 2 produces no perceptible change in the natural mode of oscillation or tone of rods 8. Filaments 10 have suitably been formed of any flexible material, preferably material having some elasticity; certain commercially available plastic fibers have proven altogether suitable.

If rods 8 were allowed to vibrate entirely freely the tones produced thereby would be of a duration too great for playing of average rapidity. In order to dampen slightly the vibration of rods 8, without adversely affecting their tone, there is provided opposite the upper end of each rod a bolt 34 extending through member 12 and adjustably secured thereto by means of nuts 36. The head 34a of bolt 34 bears on its underside a felt pad 38 which in turn lightly bears against the upper end of rod 8 and imposes a slight resistance to the vibrations of rod 8 which causes these vibrations to be more rapidly damped. Pressure of pad 38 on rod 8 may be varied by nuts 36 on the bolt 34 so that the duration of the tones produced by rods 8 may be adjusted as desired.

The operation of the device shown is as follows: Depression of keys on the keyboard causes energization of solenoids 26, and actuation of hammers 24 to strike rods 8 and set them in oscillation for a time determined by the adjustment of nuts 36 on bolts 34. As rods 8 oscillate they induce in coils 18 corresponding electrical signals which are amplified by amplifier 20, con-

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trolled as to volume by volume control 20a and converted into audio sounds by loudspeaker 22.

The instrument shown in Figures 4 and 5 comprises rods 40 which are similar to rods 8 of the instrument previously described. Each of the rods 40 is supported by means of a looped filament 42 passing through a hole 40a in the upper end of rod 40 and over a cross head 44a on the lower end of a bolt 44 which is adjustable on a transversely extending bracket 46 by nuts 45. This method of suspension is of the same practical effect as that shown in the embodiment of Figures 1 and 2 and is interchangeable therewith. The lower ends of rods 40, however, are free of any physical connection. Instead, a small permanent magnet 48 is mounted adjacent the lower end of each of the rods 40, the magnet 48 being centered below the position which the lower end of rod 40 will occupy when at rest, and being oriented so as to present toward the end of rod 40 a magnetic polarity opposite to that of said end so as to attract it toward its static position. Magnets 48 have the effect on rods 40 of diminishing both the amplitude and the duration of the vibration thereof, without materially affecting the tone. Magnets 48 are supported in vertical holes 50a in a transversely extending bar 50 and adjustably positioned with respect to rods 40 by means of set screws 52.

Rods 40 are excited by means of hammers 54 actuated by solenoids 56 (Figure 5); these hammers and solenoids are generally similar to those shown in the previous embodiment, the hammers 54 having a non-magnetic head 54a and a magnetic shank 54b, and being slidably received in the bore of helical solenoid 56. In the present instrument, however, the rearward bias of hammers 54 is imparted by a spring 58 compressed between a pin 60 extending through hammer 54 and a plate 62 depending from an upper panel member 64 of the instrument. The rearward movement of hammer 54 is limited by a bolt 66 which is adjustably secured by nuts 72 to a bracket 68 extending from a rear panel member 70. The head of bolt 66 bears a felt pad 74 which acts as a cushion for hammer 54. The operation of hammer 54 by solenoid 56, and energization of solenoid 56 in turn by the keys on the keyboard is in the same fashion as that previously described. The solenoids 56 are completely enclosed in a shielded compartment 76 of non-magnetic material so that the pickup coils 78 will not be affected by the solenoids 56.

In the present embodiment, pickup coils 78 are helically wound directly on rods 40. They are connected in series across the input of an audio amplifier which in turn is connected to a loudspeaker in the manner shown in Figure 3. The winding of pickup coil 78 directly on rods 40 substantially eliminates any relative transverse movement between coil 78 and rod 40 so that the transverse vibrations of rod 40 will induce no appreciable signals in coil 78. Coil 78 will thus detect only the longitudinal vibrations of rod 40. The effect on the tonal quality of eliminating the transverse vibrational components from the composite signal is to raise the apparent pitch. The present instrument thus produces tones of different timbre than those produced by the instrument previously described.

In both types of instrument the method of support of the rods is such as to prevent excessive amplitudes of vibration thereof and substantially to eliminate the possibility that adjacent rods will physically interfere with one another as is pos-



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sible where the rod is unsupported at the lower end—the common practice in such instruments heretofore. This allows rods 40 to be spaced at close intervals and extreme compactness achieved. While these methods of support have been shown as utilized in electronic chimes, their advantages are equally applicable to purely mechanical chimes.

In Figure 6 is shown another feature of my invention which may be utilized in either of the types of instrument described. This feature comprises an electromagnet 80 mounted adjacent each of the tone rods; as shown, electromagnet 80 may suitably be adjustably supported in plate 62 by means of a set screw 31. The electromagnet 80 consists of a soft iron core 80a on which is wound a coil 80b. The coils 80b of all of the electromagnets 80 are connected in series to a variable source of electrical current 89. Energization of electromagnets 80 by passage of current through coils 80b sets up a magnetic field in the vicinity of coil 78. As the rods 40 vibrate, coil 78 moves relatively to electromagnet 80, cutting across lines of force in its magnetic field and inducing in coils 78 signals which reflect not only the longitudinal vibration of the rods but also their transverse vibration. This results in lowering the apparent pitch of the tones produced by the instrument. By varying the current flowing through electromagnets 80, the proportion of the composite signal detected by coils 78 which was induced by transverse vibration of rods 40 may be controlled and thus some measure of control of the timbre of the instrument achieved.

In Figures 7 and 8 are shown alternative forms of tone rods which may be used in either of the types of instrument shown. These rods are designed to allow use in the tone rods of metals such as alloys of copper and tin and the like which though non-magnetic, are desirable for their excellent tonal quality. In Figure 7 the tone rod 82 which may be composed of either non-magnetic or magnetic material and may be either solid or hollow, bears a coating of a finely powdered permanently magnetized metal, such as Alnico. This coating 84 may be applied by dusting the metal on rod 82 after spreading glue on the portion of the rod which is desired to be coated. Only that portion of rod 82 which will be immediately adjacent the pickup coil need be coated with the powder.

In Figure 8 is shown an alternative method which is applicable only where a hollow tone rod is used. In the bore 86a of the rod 86, in the region which will be adjacent the pickup coil, is placed a small cylindrical magnet 88 which may suitably be held in position in rod 86 merely by friction.

In operation tone rods of the types shown in Figures 7 and 8 produce the same effect as those in the instruments already shown. Neither addition of powder, as shown in Figure 7, nor of a magnet, as shown in Figure 8, subjects the rod to an appreciable change in pitch or timbre.

There will thus have been provided means whereby the aforementioned and other obvious desirable objects may be achieved; however, as many changes might be made in the embodiment set forth, all matter hereinabove set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A musical instrument comprising a plu-

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ality of tuned vibrating elements, a striker mounted adjacent each of said elements and operable to strike such element, means for selectively actuating said strikers, a pick-up winding carried by each element whereby longitudinal vibrations of said elements induce electrical currents in said pick-up winding, magnet means adjacent said pick-up winding for controlling the effect of transverse vibrations of said elements on the electrical currents induced in said windings, and means adjacent the lower end of said element for resisting excessive vibration thereof.

2. A musical instrument comprising a plurality of tuned rods each suspended by a flexible filament attached near an end of such rod, a striker mounted adjacent each of said rods and operable to strike such rod, means for selectively actuating said strikers, a pickup winding carried by each rod whereby longitudinal vibrations of said rods induce electrical currents in said pick-up winding, magnet means adjacent said pickup winding for controlling the effect of transverse vibrations of said rods on the electrical currents induced in said windings, and a second flexible filament attached to said rod at a point remote from said end whereby to resist excessive amplitudes of vibration of said rod.

3. In a chime musical instrument, a plurality of tuned rods each suspended by a spaced pair of flexible filaments whereby to resist excessive amplitudes of vibration of said rod, a striker mounted adjacent each of said rods and operable to strike such rods, means for selectively actuating said strikers, a pickup winding carried by each rod whereby longitudinal vibrations of said rods induce electrical currents in said pickup winding, and magnet means adjacent said pickup winding for controlling the effect of transverse vibrations of said elements on the electrical currents induced in said windings.

4. In a chime musical instrument, a plurality of tuned rods each suspended by a flexible, elastic filament at each end thereof whereby to resist excessive vibration of said rods, a striker mounted adjacent each of said rods and operable to strike such rods, means for selectively actuating said strikers, a pickup winding carried by each rod whereby longitudinal vibrations of said rods induce electrical currents in said pickup winding, and magnet means adjacent said pickup winding for controlling the effect of transverse vibrations of said elements on the electrical currents induced in said windings.

5. A musical instrument comprising a plurality of tuned rods each suspended by a flexible filament attached near an end of such rod, a striker mounted adjacent each of said elements and operable to strike such element, means for selectively actuating said strikers, a pickup winding carried by each element whereby longitudinal vibrations of said elements induce electrical currents in said pickup winding, magnet means adjacent said pickup winding for controlling the effect of transverse vibrations of said elements on the electrical currents induced in said windings, and a magnet adjacent the lower end of said rod whereby to resist excessive vibration thereof.

6. In a musical instrument of the type comprising a plurality of tuned rods suspended at one end by a flexible filament, means for damping vibration of said rods comprising a magnet adjacent each of said rods, each magnet being located and oriented so as to urge said end toward its static position, a striker mounted adjacent each of said rods and operable to strike such



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rod, means for selectively actuating said strikers, a pickup winding carried by each element whereby longitudinal vibrations of said elements induce electrical currents in said pickup winding, and magnet means adjacent said pickup winding for controlling the effect of transverse vibrations of said elements on the electrical currents induced in said windings.

7. A musical instrument comprising a plurality of magnetized rods tuned to various frequencies of vibration, each of said rods being supported at one end by a flexible filament, a striker mounted adjacent each of said rods and operable to strike such rod, means for selectively actuating said strikers, a magnet adjacent the lower end of said rod, and oriented so as to urge said end toward its static position, a pickup coil adjacent each of said rods whereby electrical signals are induced in said coils by the vibration of said rods, magnet means adjacent said pickup winding for controlling the effect of transverse vibrations of said elements on the electrical currents induced in said windings, and means for amplifying said signals and a loud-speaker for converting said signals into sound waves.

8. A musical instrument comprising a plurality of rods tuned to various frequencies of vibration, each of said rods being supported at one end by a flexible filament, a striker mounted adjacent each of said rods and operable to strike such rod, means for selectively actuating said strikers, a pickup coil wound on each of said rods whereby the longitudinal vibration of such rod induces electrical signals in said coil, an electromagnet adjacent each of said coils, a variable source of current for such electromagnets, an audio amplifier for amplifying said signals and a loud-speaker for converting said signals into sound waves.

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9. In a musical instrument of the type wherein the oscillation of tuned freely suspended rods of magnetic material induce in coils wound on said rods signals which are amplified and converted into sound waves, means for varying the output tone of said instrument comprising an electromagnet mounted adjacent each of said coils and a variable source of electrical current therefor.

10. In combination, a tuned member, means for freely suspending said member, means for vibrating said member, and means for translating the vibrations of said member into sound waves; said member having a magnetized portion adjacent one end thereof, a pick-up winding carried by said portion whereby vibrations of said member induce electrical currents which are converted into sound waves; said member having a second magnetized portion adjacent the other end thereof, and magnet means cooperating with said second portion for urging said other end toward its static position.

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