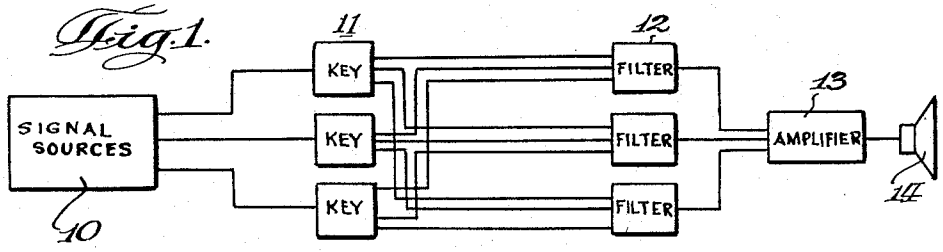
Nov. 5, 1963 T. B. GIBBS 3,109,341

KEY SWITCH

Filed June 9, 1960

Fig. 1.



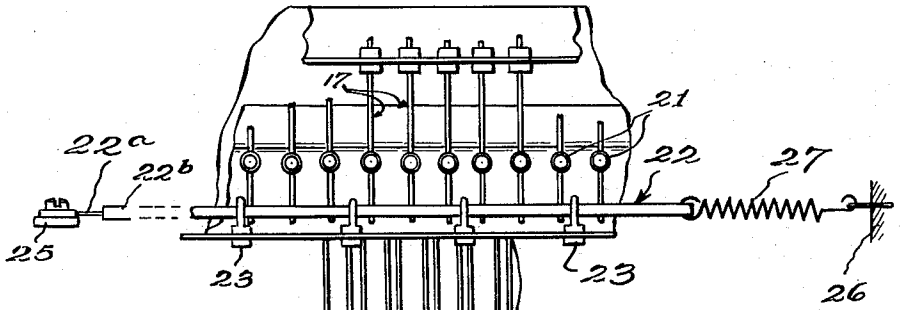


Fig. 2.

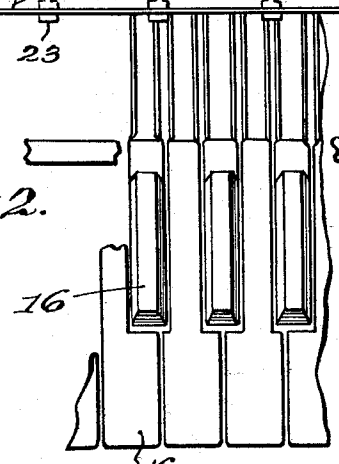


Fig. 4.

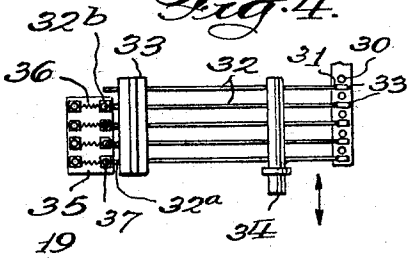
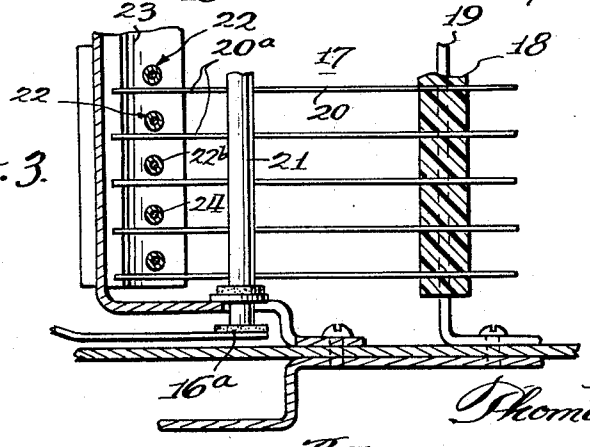


Fig. 3.



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KEY SWITCH

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3 Claims. (Cl. 84—423)

This application is concerned with a key switch for an electronic musical instrument.

In an electronic musical instrument, as an electronic organ, the keyboard is provided with a key switch mechanism actuated by the various keys to effect the reproduction or generation of desired tone representing signals. Often a multiple cotnact switch arrangement is utilized, one switch assembly being provided for each key of the instrument, and corresponding contacts of each key switch assembly being engageable with appropriate bus conductors. In certain types of instruments, and particularly those where the tone representing signal itself is directly switched by the key actuated switches, problems have been encountered from key noise or key clicks introduced upon engagement of the key contact with the bus.

It has been proposed that the key noise could be reduced or eliminated by providing spaced conductive rubber coatings on the active sections of the bus wires, establishing an appreciable contact resistance. In the previous arrangement for accomplishing this, the bus wires were supported by mounting plates located between the active bus sections on which the conductive rubber covering is located, with the conductor rigidly secured to the supports at each supporting point, preventing sag of the bus conductor. This construction is particularly time consuming and difficult to assemble.

A principal object of the present invention is the provision of improved key switch mechanisms with conductive coating means on the contact surfaces for reducing or eliminating key click effects.

One feature of the invention is the provision in the key switch means of an elongated bus conductor arranged for engagement by the contact member of an actuated key switch having a continuous sleeve of conductive material thereon with a plurality of spaced support members for the bus and means placing the bus under tension. Another feature is that the bus supporting plates have openings therein which slidably receive the bus conductor which is held under tension, as by a spring.

A further feature of the invention is that the conductive coating for the key switch element has a resistance variable with the pressure of the contact and several times greater upon initial contact of the switch contact member and bus than with complete actuation of the key switch.

Still another feature is that each key switch assembly has a plurality of contact members with the contact surfaces thereof coated with a resistive material. Yet a further feature is that the multiple contacts have terminal ends projecting from a mounting block, in alignment, and an insulating plate with areas of resistive material thereon and having connection portions along one side, receiving the terminal ends of the key contacts, connecting each of them with one of the resistive areas.

Further features and advantages of the invention will readily be apparent from the following specification and from the drawings, in which:

FIGURE 1 is a simplified block diagram illustrating the basic elements of an electronic musical instrument pertinent to the present invention;

FIGURE 2 is a fragmentary plan view of a keyboard and key switch embodying the invention;

FIGURE 3 is a section taken generally along line 3—3 of FIGURE 2; and

FIGURE 4 is a reduced elevation of a modified key switch construction.

Key noise or clicks are a problem in many types of electronic musical instruments, but are particularly troublesome in those systems where the tone representing signals are controlled directly through the key switch, as contrasted with keying a control signal or the like. Even though the tone handling circuitry generally includes a substantial fixed resistance connected in series with the key switch, transients initiated upon contact in the switch and noise resulting from the contact, and often accentuated by dirty switch surfaces, are objectionable.

FIGURE 1 illustrates, in block form, certain basic elements of an electronic musical instrument including sources **10** of tone representing signal, which may comprise a series of control oscillators and frequency dividers, key switches **11** which may be actuated to select the desired signal or combination of signals from sources **10** and to connect them with suitable tone modifying filters **12** to provide signals which accurately represent the tones to be produced. The outputs of filters **12** may be coupled to an amplifier **13** and reproducer or loudspeaker **14**. The particular harmonics utilized and the nature of the filters **12** may be determined by selector or stop switches (not shown).

In FIGURE 2, a portion of the keyboard of an electronic organ is illustrated having manually operable keys **16**, which actuate associated key switch assemblies **17**. With particular reference to FIGURE 3, each key switch assembly **17** includes a support or terminal block member **18**, of an insulating material, carried by a plate **19**. A plurality of key switch elements or wires **20** are mounted at one end in the terminal block **18** and have contact portions **20***a* which extend outwardly therefrom, in vertical alignment. An insulating spacer and actuator member **21** is mounted on the switch wires **20**, adjacent the contact portions **20***a* thereof, holding the switch elements in fixed relation to each other.

A plurality of bus conductors **22** are provided one for each switch element **20** of the switch assemblies **17**. The bus conductors **22** run the length of the keyboard and are supported by a plurality of members **23** spaced along the length thereof. Each of the keys **16** has a portion **16***a* which extends or projects below the lower end of actuator member **21** and upon depression of key **16** the end portion **16***a* pivots upwardly lifting actuator **21** and bringing the end portion **20***a* of each of the switch elements **20** into contact with the associated bus conductor **22**. Further details of the general construction of the keyboard may be found in Gibbs et al. application Serial No. 829,285, filed July 24, 1959, now Patent No. 3,068,334, and assigned to the assignee of this invention.

The bus conductors **22** each include a conductor wire **22***a* covered by a continuous sleeve **22***b* of a conductive, low resistance material. The bus conductors **22** are carried in aligned openings **24** in the support members **23**, the openings being slightly smaller than the outer diameter of the covering **22***b* so that the bus conductors are held in a fixed position, but may be pulled through the openings by the application of a small amount of force. One end of the conductor **22** is fixed, as by securing wire **22***a* to a terminal block **25**. The opposite end of the bus conductor **22** is connected with a fixed support **26** by a spring **27** which places the entire bus conductor under tension, holding it tight and eliminating sag between the supports **23**. The tension force supplied by spring **27** is greater than the restraining frictional force on the bus conductor **22** from the supports **23**.

The bus conductors may easily be assembled by merely threading them through the supports **23**, securing the conductor at one end with terminal board **25** and attaching tension spring **27**. There is no rigid physical connec-

tion between the bus conductor and the individual supports 23.

The covering 22*b* on the bus conductors 22 is preferably a rubber material with particules of carbon therein providing a relatively low contact resistance between the individual switch elements 20 and the conductor 22*a*. The resistance in the switch varies with the pressure applied between the contact portions 20*a* of the switch elements and the conductor and is preferably several times greater upon initial contact than with the key elements fully raised. For example, the initial contact resistance may be of the order of 10,000 ohms and drop to 1,000 ohms upon full depression of the key. The end portions 20*a* of the switch elements are preferably plated, as with gold, to reduce corrosion. Furthermore, the flakes of carbon in the rubber coating of the bus conductors have a slight abrasive action which tends to clean the tips of the contact wires as they wipe across the bus when actuated.

A modified form of the invention is illustrated in FIGURE 4. Here, the bus conductors 30 are merely bare wires, which may be gold plated, and the tip portions 31 of the individual switch elements 32 are coated with a conductive material, 33, as rubber with graphite flakes. This arrangement reduces the quantity of graphite containing rubber required in the instrument.

The switch assembly is preferably preassembled, with the switch elements 32 being mounted with the terminal or support block 33 and the spacer-actuator 34. The aligned end portions 31 of the switch members are then dipped in a liquid rubber material containing the desired proportion of graphite flakes; and the coating cured.

In a system where series resistors are connected with the key contacts, it is convenient and desirable to utilize printed resistors. An insulating plate 35, which may be of a ceramic material, has resistors 36 formed thereon by suitable printing process. Along the edges of plate 35 are a series of openings 37 to which circuit connections may be made. The terminal ends 32*a* of the switch elements extend from mounting block 33, generally in vertical alignment and have hooked end portions 32*b* formed therein which are received in the openings 37 in plate 35 and suitably secured thereto, as by soldering. The aligned relationship of the terminal end portions 32*a* of the switch elements and the use of the printed resistor plate 35 facilitate assembly of the circuit, eliminating a great deal of hand connection and soldering which would otherwise be required. Further circuit connections may be made to similar openings or the opposite edge of plate 35.

The dipped coatings 33 on the key switch elements are preferably much thinner than the covering 22*b* of bus wires of FIGURES 2 and 3, and the resistance introduced is somewhat less. In a specific system, the coatings may have a resistance of the order of 50 to 200 ohms and the series resistors 36 are preferably of the order of 100,000 oms. Thus a substantial variation in the value of the resistance in the switch tip coating is permissible.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. In an electrical musical instrument having a plurality of linearly arranged selectively actuatable playing keys with individual contact members movable by individual ones of said keys, a bus bar extending linearly in a position to be engaged transversely by any of said contact members upon the actuation of appropriate keys, said bus bar comprising a long, thin, flexible wire, and mounting means for said wire including resilient means connected to at least one end of the wire to apply a tensional force to said wire sufficient to hold said wire substantially straight and for preventing appreciable lateral displacement of said wire when said wire is transversely engaged by one or more of said contact members.

2. In an electrical musical instrument having a plurality of linearly arranged selectively actuatable playing keys with individual contact members movable by individual ones of said keys, a bus bar extending linearly in a position to be engaged transversely by any of said contact members upon the actuation of appropriate keys, said bus bar comprising a long, thin, flexible wire, mounting means for said wire including resilient means connected to at least one end of the wire to apply a tensional force to said wire sufficient to hold said wire substantially straight and for preventing appreciable lateral displacement of said wire when said wire is transversely engaged by one or more of said contact members, and said wire having a coating thereon formed of an electrically conductive elastomer.

3. In an electrical musical instrument having a plurality of linearly arranged selectively actuatable playing keys with individual contact members movable by individual ones of said keys, a bus bar extending linearly in a position to be engaged transversely by any of said contact members upon the actuation of appropriate keys, said bus bar comprising a long, thin, flexible wire, mounting means for said wire including resilient means connected to at least one end of the wire to apply a tensional force to said wire sufficient to hold said wire substantially straight and for preventing appreciable lateral displacement of said wire when said wire is transversely engaged by one or more of said contact members, and a plurality of spaced intermediate support members for said wire, said intermediate support members having aligned apertures therethrough forming a loose fit with said wire and through which said wire is threaded.

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