Nov. 20, 1962 F. C. BREWSTER 3,064,494

INSERT BUSHING

Filed Nov. 23, 1959

Fig. 1.

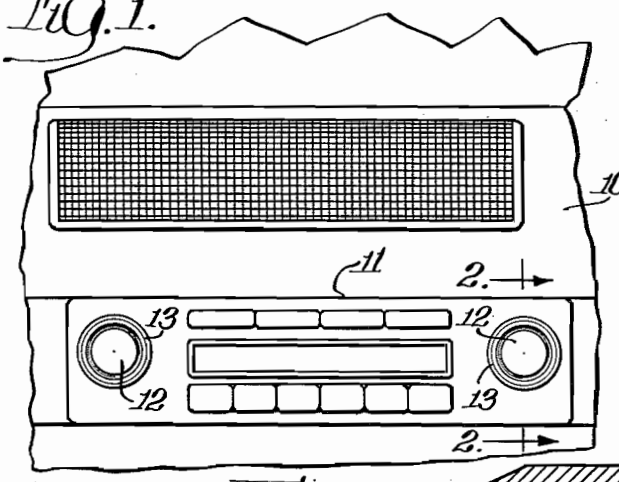


Fig. 3.

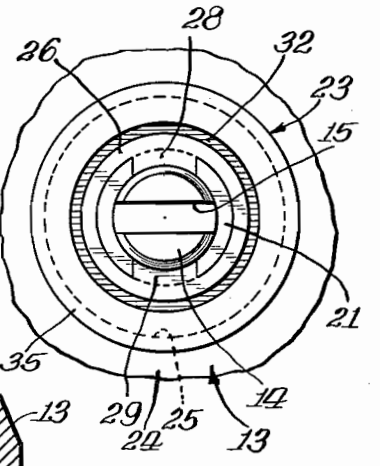


Fig. 2.

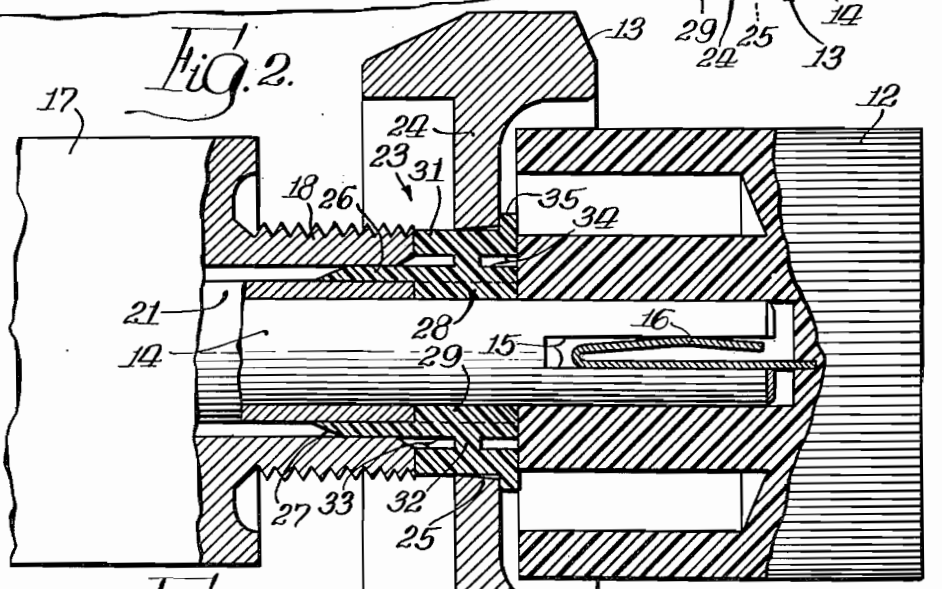
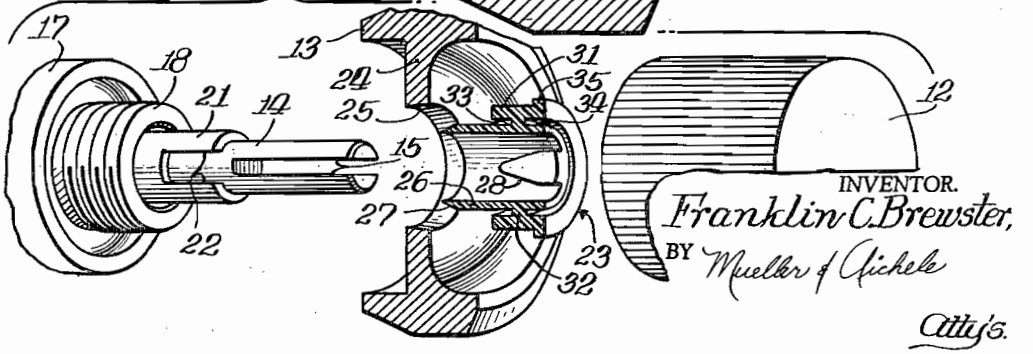


Fig. 4.



INVENTOR.
Franklin C. Brewster,
BY Mueller & Aichele
Attys.

United States Patent Office 3,064,494 Patented Nov. 20, 1962

3,064,494
INSERT BUSHING

Franklin C. Brewster, Franklin Park, Ill., assignor to Motorola, Inc., Chicago, Ill., a corporation of Illinois

Filed Nov. 23, 1959, Ser. No. 854,917
6 Claims. (Cl. 74—504)

This invention relates to an improved removable knob for shaft controlled apparatus, and more particularly to a bushing device for supporting a manual control knob on a shaft for functions such as tuning, volume and tone in a radio receiver.

To save space and components, electronic apparatus and particularly radio receivers such as those used in automobiles may have controls combined in one location by concentrically mounting one or more hollow shafts over a solid shaft. Each shaft may then be operated by an individual control knob. It is also desirable to have the control knobs easily removable from the control shafts so that the apparatus may be disassembled for mounting, adjustment and repair with a minimum of effort.

The inner knob which is used to rotate the hollow shaft has heretofore been designed to be removable by providing a clearance fit between the inside diameter thereof and the outside diameter of the hollow shaft. Driving engagement between the knob and hollow shaft has commonly been achieved by providing one or two tines in the knob hole wall which function as keying means. The maximum clearance between the knob hole and hollow shaft must be kept small because automobile vibration will cause rattle of the knob on the shaft and consequent customer dissatisfaction. However, the cost of manufacture increases rapidly as the tolerances are reduced and thus it is important that the tolerances be specified at the largest values which operating considerations will permit.

The outside diameter and the keyways of the hollow control shaft may be held to reasonably close tolerances. The control knob hole details, however, present several production problems. Knobs produced by the die casting process are preferred, but production run-out of hole detail tolerances may result from normal wear of the core pins used in this process. In addition, the exterior corners of the core pin tend to break off and the interior corners tend to solder shut, producing a poor fitting tine. It is also necessary to provide a draft angle or taper in the hole, generally on the order of one degree, so that the part can be removed from the die. Tolerance variations may also be introduced in a following buffing operation when the parts are chucked using the tines as driving surfaces. Another random distortion may be introduced in a plating operation when the knobs are forced onto and removed from electroplating pins which tend to plate to larger diameters during production runs. Hitherto, there has been no simple effective compensating device which is capable of taking up all the tolerances so introduced while maintaining the desired accurate sliding fit of the knob on the shaft.

A related problem has been the rattle of the outer control shaft against the sub-escutcheon mounting boss of the radio. In order to minimize or eliminate this rattle a sleeve may be added over the shaft, but this will necessarily increase material and labor costs in a highly competitive mass production market.

It is therefore an object of the present invention to provide an improved removable control knob assembly which permits the use of knobs having variations and imperfections in their center hole diameter and contour.

A further object of the invention is to provide an easily constructed bushing manually insertable in a control knob center hole, which will fit in a center hole having variations in diameter, surface imperfections and tapered contour, and will also accurately engage and fit a control shaft.

A still further object of the invention is to provide a control knob assembly having improved insertable means for easily, accurately and removably fitting a knob to automobile radio control shafts thereby substantially reducing wobble of the knob and rattle of the supporting shaft and eliminating the need for precise construction of the knob and the shaft.

Another object of the invention is to provide an improved insert for accurately and removably fitting a metal control knob to an automobile radio control shaft while insulating the knob from the shaft, from the radio mounting boss and from tandem knobs which may be mounted therewith on concentric shafts.

A feature of the invention is the provision in a control knob of a bushing with an oversize outside diameter to provide an interference fit in the knob hole while having limited compressibility to allow manual insertion in this hole. The inside diameter of the bushing will remain relatively undiminished when so fitted in the knob and thus an accurate fit of the bushing on a shaft will be maintained.

A further feature of the invention is the provision of a bushing constructed so as to have an outer structure concentric with an inner cylindrical structure and connected thereto by a narrow annular web portion, whereby uneven flexing pivoting and compression forces may react on the shape and size of the outer structure but are isolated to a large extent from the inner cylindrical structure. Thus, the effect of such forces on the shape and size of the inner cylindrical structure will be negligible, thereby maintaining a relatively stable inside diameter to provide an accurate fit on a shaft.

Another feature of the invention is the provision in an automobile radio control knob of an insert bushing construction wherein the inner end of the inner cylindrical structure is extended in length sufficient to provide a strain-free sleeve bushing between a control shaft and a radio sub-escutcheon mounting boss to facilitate insertion of the knob on the shaft and to substantially eliminate shaft rattle.

A still further feature of the invention is a control knob insert bushing which may be constructed in one piece of material, such as nylon, which will have relatively slippery surfaces to provide easier insertion on and removal from a shaft, which will also provide better bearing surfaces, will be somewhat flexible, will absorb vibrations to help reduce rattle and which may be electrically nonconducting.

Still another feature of the invention is the provision of a flange on the outer end of a control knob insert bushing to provide an insulated bearing portion between

tendem control knobs mounted on concentric control shafts.

The invention is illustrated in the accompanying drawings wherein:

FIG. 1 is an elevational view of a radio receiver installed in an automobile dashboard illustrating the use of the control knob assembly in accordance with the invention;

FIG. 2 is a greatly enlarged sectional view along the line 2—2 of FIG. 1;

FIG. 3 is an end view of the insert bushing of FIG. 2 on the control shaft; and

FIG. 4 is an exploded perspective view of the control knob assembly.

In accordance with the present invention an improved control knob assembly is provided including a bushing which is composed of two concentric cylindrical tubes spaced and connected to each other by an annular web portion. The outside diameter of the outer cylindrical tube is made oversize with respect to the center hole of a control knob with which it is to be used, while the inside diameter of the inner cylindrical tube is designed to provide an accurate fit with a control shaft. The axial dimension of the web is relatively short with respect to the axial dimension of the outer cylindrical tube so that compression and pivotal stresses caused by the interference fit in the tapered rough-tolerance control knob center hole are substantially isolated from the inner cylindrical tube. By extending the length of the inner tube sufficiently inward axially, the inner tube will serve as a bushing between the shaft and the mounting boss. On the outer end of the outer tube a flange may be provided which will separate the knob from the tandem knobs mounted therewith, and will provide a bearing surface between these knobs.

FIG. 1 of the accompanying drawing shows an automobile dashboard **10** in which is mounted an automobile radio **11** having an on-off-volume control knob **12** and tone control knob **13**. As more particularly shown in the sectional view of FIG. 2, the control knob **12** is mounted on a solid control shaft **14**. For providing secure engagement of control knob **12** with shaft **14** and for driving the shaft, a prong **16** mounted in control knob **12** is compressed in a slot **15** in the end of the solid shaft **14**. The solid shaft **14** extends from the control components in the radio receiver, not shown in the drawings, through mounting boss **17** and a threaded projection **18** thereof. A hollow tone control shaft **21** is concentrically mounted over shaft **14** and also extends from the radio chassis through the threaded projection **18**. Each side of the end shaft **21** is provided with a tine slot, as shown by tine slot **22** in FIG. 4.

The shaft **21** is driven by tone control knob **13** which is both fitted about shaft **14** and is keyed with shaft **21** by means of an insert bushing **23**, as will be described subsequently in more detail. The web portion **24** of knob **13** has a tapered center hole **25** in which the insert bushing **23** is received with an interference fit.

As shown in FIG. 2, the insert bushing **23** includes an inner cylindrical tube **26** having an inside diameter which will provide a close clearance fit with the control shaft **21**. The tube **26** is extended in axial length inward to serve as a bushing between the shaft **21** and projection **18**. A chamfered end **27** facilitates insertion of the tube **26** into the projection **18**. Projecting tines **28** and **29**, as shown in FIG. 3, are provided on the inside wall of tube **26** as a means of keying engagement between the insert bushing **23** and shaft **21**. FIG. 4 shows the configuration of the tine **28**.

The insert bushing **23** also includes an outer cylindrical tube **31** having an outside diameter which will provide an interference fit in the center hole **25** of control knob **13**. The outer tube **31** is connected to the inner tube **26** by an annular web portion **32** having a relatively short axial dimension with respect to the axial dimension of the outer

tube **31**, thereby forming annular recesses **33** and **34**. The outer end of outer tube **31** has a flange portion **35** to provide a seat against which the web portion **24** of knob **13** rests and which also provides an insulated bearing spacer between the tandem knobs **12** and **13**.

The bushing of the invention is assembled with knob **13** by inserting the elongated end of inner tube **26** through the center hole of the knob until the outer tube **31** engages the sides of center hole **25**. Then the bushing is pressed into the hole until the web **24** of knob **13** butts against the flange portion **35**. Due to the interference fit in the knob, a deflection or strained configuration will result in the outer tube and in the web portion **32**. Only a fraction of the total compressive stresses not thus absorbed are transmitted by the narrow web, resulting in a localized reflection or "strain bump" occurring on the inner wall of inner tube **26** opposite the web portion. And this deflection is less than the deflection appearing at points more radially distant therefrom due to the compressive strain gradient across the bushing. Since most of the inner tube, especially the elongated portion thereof is isolated from the effects of the press fit stresses, it is an easy matter to slide fit the knob with the bushing inserted therein onto shaft **21**. The clearance fit allows rotation of the knob until the tines **28** and **29** find their mating slots. Then, with a final inward movement, the knob is inserted fully on the shaft so that outer tube **31** of the insert bushing bears against the end surface of projection **18**. Depending on the tolerances involved, the small strain reflection on the inside of inner tube **26** may cause a slight interference fit of the bushing on shaft **21** at a point opposite the web portion resulting in a clamping effect which adds to the anti-wobble character of the invention.

The operation of the insert bushing may be enhanced by constructing it of suitable material, such as nylon, which will provide slippery surfaces for easier insertion and removal, will adapt to distortions in the knob center hole due to its limited flexibility, will absorb vibrations to a greater degree than metal, and will act as an electrical insulator.

The insert bushing **23** is preferably of one-piece construction which will allow it to be manufactured by an inexpensive one-step molding process from material such as nylon. However, other materials, such as other dimensionally stable plastics or metal, and other modes of construction, such as machining or welding a separable-part assembly could be used to achieve the inventive configuration. It is also to be understood that the configuration of the inner and outer tubes may be varied from the cylindrical form to other shapes, such as oval or square, depending upon the shape of the shaft and knob hole desired to be mounted.

The invention thus provides a bushing which may be inserted in a control knob to produce an accurate wobble-free clearance fit and easily removable engagement of the knob on the shaft. Integral fit-and-engagement structural details may thereby be eliminated from the knob hole, permitting the use of a control knob having a larger center hole free from critical dimensional and handling requirements. The insert bushing also serve as a rattle-reducing bushing between the shaft and the mounting boss of the associated equipment, thereby eliminating the need for a separate bushing to perform this function. Furthermore, the insert bushing may serve as an insulating spacer and bearing between the knob and other tandem knobs mounted on concentric shafts therewith. The inventive configuration of the insert bushing permits one-piece construction, and consequently is well adapted to one-step low unit cost mass-production molding or machining methods.

I claim:

1. An insert bushing for removably slide fitting a turning element having a center opening to a rotatable shaft, said bushing including an inner cylindrical tube for directly mounting on the shaft and having an inside diam-

eter which provides a close clearance fit thereon, an outer tube encircling said inner cylindrical tube and having an outer contour which will provide an interference fit in the opening in the turning element, and an annular web portion connecting said inner cylindricel tube to said outer tube, said web portion having a relatively short axial dimension with respect to the axial dimension of said outer tube whereby stresses acting on said outer tube resulting from the interference fit are substantially isolated from said inner cylindrical tube to maintain therein a relatively fixed inside diameter to accurately fit said bushing on the shaft.

2. In an automobile radio having a mounting boss with a control shaft extending therethrough and having a diecast control knob which has a center hole the dimensions of which are subject to variations, a bushing for removably slide fitting the control knob to the control shaft including, an inner cylindrical tube having an inside diameter which will provide a close clearance fit of the knob on the shaft, keying means projecting from the inner surface of the inner tube and directly engaging the shaft, an outer cylindrical tube encircling said inner tube and having an outside diameter slightly oversized with respect to the knob hole to provide an interference fit of the bushing in the knob, said outer tube having a flange portion on the outer end thereof, an annular web connecting the outer tube to the inner tube and radially spacing said cylindrical tubes from each other, said web having a relatively short axial dimension with respect to the axial dimension of the outer tube whereby stresses acting on said outer tube resulting from the interference fit are substantially isolated from said inner tube, said inner tube extending axially inward beyond said outer tube to provide a bushing between the control shaft and the mounting boss.

3. The structure according to claim 2 wherein the bushing elements are integrally constructed in one piece.

4. The structure according to claim 2 wherein the bushing is composed of nylon.

5. In an automobile radio receiver having a mounting boss and a hollow control shaft concentrically and rotatably mounted over a solid control shaft extending through the mounting boss an outer control member on the solid shaft, an inner die cast knob to rotate the hollow shaft and formed with a center hole therein the dimension of wihch is subject to variation, said hollow control shaft being formed with a plurality of keyways therein, a bushing for removably slide fitting the knob to the hollow control shaft including an inner cylindrical tube having an inside diameter to provide a clearance fit of the knob on the hollow shaft, keying means projecting from the inner surface of the inner tube and extending into said keyways formed in the hollow shaft and into engagement with said solid shaft, an outer cylindrical tube encircling said inner cylindrical tube and having an outer diameter slightly oversized with respect to the knob hole to provide an interference fit of the bushing in the knob, said outer cylindrical tube having a flange portion formed upon the outer end thereof to abut against the knob upon assembly of the bushing in the knob, said flange portion engaging said outer control member, an annular web connecting said outer cylindrical tube to said inner cylindrical tube and spacing said tubes form each other, said web having a relatively short axial dimension with respect to the axial dimension of said outer cylindrical tube, said inner tube extending axially inward beyond said outer cylindrical tube to provide a bushing between the hollow control shaft and the mounting boss.

6. An insert bushing for removably slide fitting a turning element having a center opening to a rotatable shaft, said bushing being formed of resilient material and including an inner cylindrical portion, an outer cylindrical portion about said inner portion and an annular web connecting said inner and outer portions, said inner cylindrical portion having an inside diameter which provides a clearance fit on the shaft, said outer cylindrical portion having an outer surface shaped to provide an interference fit in the opening in the turning element, said web portion having a relatively short axial dimension as compared to the axial dimension of said outer cylindrical portion, whereby stresses acting on said outer portion resulting from the interference fit are substantially isolated from said inner cylindrical portion to maintain therein a relatively fixed inside diameter to accurately fit said bushing on the shaft.

References Cited in the file of this patent

UNITED STATES PATENTS

1,575,410	Bradley	Mar. 2, 1926
1,697,814	Forbes	Jan. 1, 1929
2,456,949	Keim	Dec. 21, 1948
2,502,915	Atkins et al.	Apr. 4, 1950
2,578,809	Ketchum	Dec. 18, 1951
2,647,774	Newberry	Aug. 4, 1953
2,672,764	Bedford	Mar. 23, 1954
2,704,232	Johnston et al.	Mar. 15, 1955
2,757,054	Van De Warker	July 31, 1956
2,884,283	Korol et al.	Apr. 28, 1959
2,913,284	Zankl	Nov. 17, 1959
2,981,573	Reuter	Apr. 25, 1961

FOREIGN PATENTS

145,669	Great Britain	Mar. 10, 1921
595,830	Great Britain	Dec. 18, 1947
1,099,899	France	Mar. 23, 1955
1,208,127	France	Sept. 7, 1959