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Standing

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[54] **OIL FILLED STEPPING SWITCH**

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[52] **U.S. Cl.**..... **200/8 R,** 200/8 A, 200/11 TC

[51] **Int. Cl.**..... **H01h 19/56,** H01h 21/76

[58] **Field of Search**..... 200/8 A, 8 R, 11 TC

[56] **References Cited**

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[57] **ABSTRACT**

A high voltage oil filled stepping switch connects a plurality of DC voltage sources to a common output terminal. The rotor and housing is formed of plastic and contains appropriate grooves and flutes to increase electrical resistance to voltage breakdown while increasing the oil storage space. A flexible self-aligning shaft incrementally positions the rotor contacts with the housing contacts.

11 Claims, 2 Drawing Figures

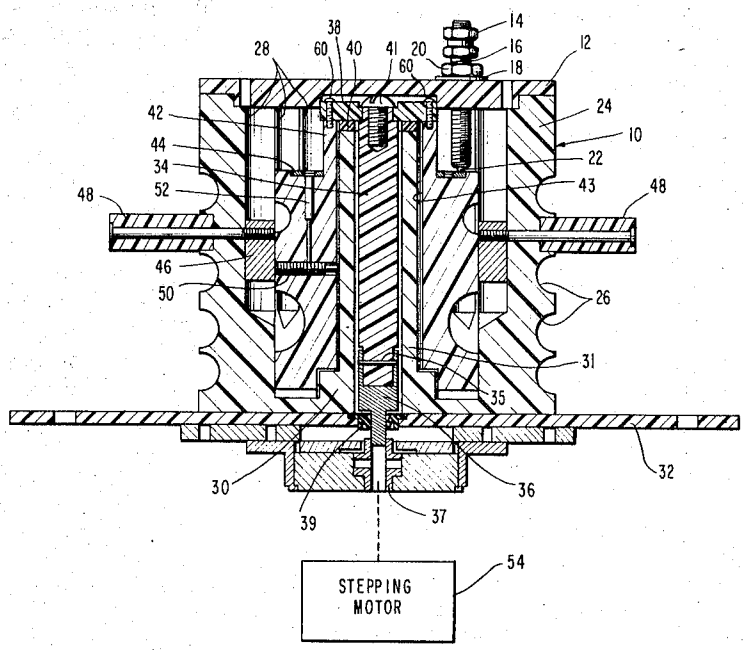


FIG. 1

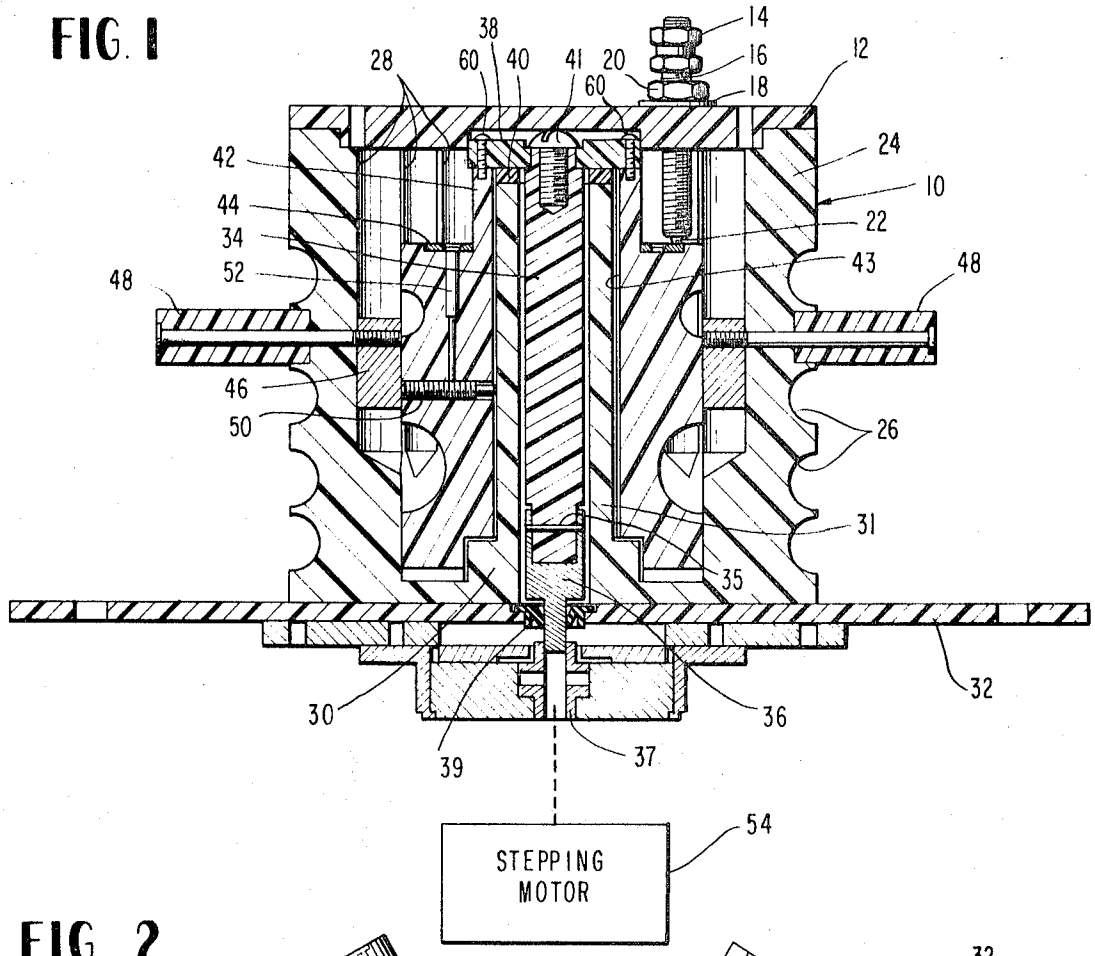
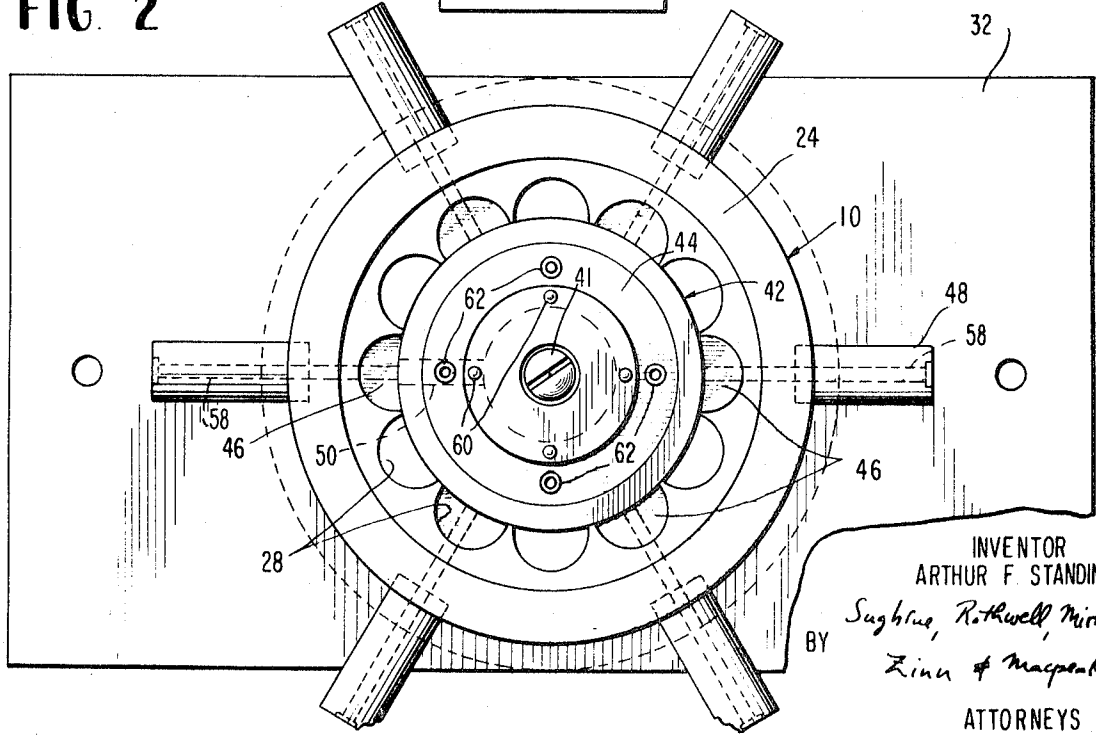


FIG. 2



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OIL FILLED STEPPING SWITCH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to an oil filled stepping switch that provides a plurality of high-voltage DC current sources to a common output terminal. More particularly, the present invention relates to an oil filled, break-before-make, stepping switch which can selectively connect one of a plurality of high voltage DC sources to a common output terminal for providing a variable source of voltage to a modulating anode of a high power transmitter tube.

2. Brief Description of the Prior Art

The higher voltage stepping switches generally available have failed to meet the requirements of the high power TWT (traveling wave tube or other tubes) utilized in high power transmitting stations such as those which communicate via a satellite. Generally the tubes must be provided with a source of adjustable voltage to the modulation anode to thereby control both RF power output and DC power consumption. Attempts have been made to utilize both low voltage switches and elaborate three-phase on-off switches in modulating the anodes of the tubes. These attempts have included providing a completely separate power supply and a relay system with incremental units of resistance. However, the problems associated with turning the high power units off and on, rather than just their voltage and in providing a sufficiently high voltage range, have proved beyond the capacities of the prior art stepping switches.

Thus the prior art devices have left the high power tubes extremely vulnerable to the damaging effect upon the tubes and the corresponding circuitry when the switch arcs upon the application of increments of high voltage.

SUMMARY OF THE INVENTION

The present invention provides a relatively inexpensive and effective means of protecting the tubes from overload, while at the same time permitting a reasonable current to be carried over a long life. The present switch is quite capable of providing incremental voltage steps from zero to 20 kilovolts while at the same time maintaining a compact structure that is both cheap and relatively easy to assemble.

These features of the invention are accomplished by providing a cylindrical stator housing having a plurality of input terminal contacts positioned in a common plane around the inside surface of the housing. A self-aligning shaft is rotatable within and concentric to the cylindrical housing while a sleeve rotatably by the shaft includes a single contact element for selectively engaging one of the input terminals. The contact element is securely fastened to the sleeve. The shaft is flexible due to both the elasticity of the nylon rotor shaft and its two part construction utilizing an adaptor. The flexibility improves both the operation of the switch and facilitates its initial construction. A pin connects the shaft and adaptor. An appropriate conductive ring is connected to the contact element for providing an electrical path through a brush member in sliding contact with the conductive ring and an output terminal. A stepping motor is utilized for the appropriate incremental movement of the alignment shaft. The interior of the housing and the rotor are provided with grooves and

flutes to increase both the oil capacity of the housing for long life and to provide an extra electrical length to prevent electrical breakdown. Likewise the exterior of the housing has appropriately placed grooves to increase the resistance to voltage breakdown. A non-inflammable oil such as ASKAREL is utilized to reduce arcing between the input terminals and the rotatable brush element and for providing a rotational damping and lubricating function. By utilizing this particular arrangement of parts and be carefully choosing the appropriate material to construct the various elements of the stepping switch the device of the present invention has the particular advantages of high voltage isolation between each of the input terminals as well as with the indexing mechanism while remaining relatively simple and inexpensive to construct. Generally, nylon is favored as the constructional material for electrically isolating the switch terminals.

A particular aid in the construction and operation of the oil filled stepping switch of the present invention is the self-aligning feature of the rotor shaft. The stator housing itself contains interior flutes which simply increase the length of the electrical leakage path between the electrical contacts. These flutes serve a further advantage by providing a reservoir for the oil and a convenient positioning or locating reference during the assembly of the switch. Circumferential grooves on the rotor both above and below the brush contact point further help increase the relative length of the electrical leakage path and thus protect against voltage breakdown. Similar grooves on the outside body of the switch also increase the length of the relative electrical leakage path. Generally, the switch is preferably sealed to make it air-tight and the maximum grounding effect possible is provided.

DESCRIPTION OF THE DRAWINGS OF THE PREFERRED EMBODIMENT

FIG. 1 is a sectional side elevational view of the present invention.

FIG. 2 is a plan view of the switch of the present invention with the cover removed.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 the housing or stepping switch body **10** is appropriately connected for example by four connecting members (not shown) to the cover **12**. Both the cover **12** and the stator housing **10** can be made from nylon. Appropriate sealing means can be provided to insure an air tight seal. An outer terminal **14** located on the cover or closure **12** comprises a threaded stud **16** that terminates in a stud contact portion **22** with a washer **18** and a locating bolt **20** for firmly attaching the threaded stud **16** in position. The stud **16** can be brass or copper and the washer **18** a plastic such as Teflon. The cylindrical walls **24** of the stepping switch housing **10** are fluted on the interior with flutes **28** and have circumferential grooves **26** on the exterior. The flutes **28** and circumferential grooves **26** both increase the relative electrical leakage path to help prevent electrical breakdown of the stepping switch. It has been found that circular fluted cuts and semi-circular radial grooves are advantageous shapes respectively for the flutes **28** and circumferential grooves **26**. The base member **30** of the stepping switch body **10** has a stepped cylindrical portion **31** with an

axial bore for receiving the flexible drive shaft means which comprises the rotor drive shaft **34** and the adaptor **36.** Both the base **30,** the cylindrical portion of the base **31** and the rotor drive shaft **34** are preferably constructed of nylon. The rotor drive shaft **34** is fastened to adaptor **36** by pin **35.** The adaptor **36** is preferably constructed of an aluminum alloy and includes a lower stud member **37** for connecting the input of incremental motion from a stepping motor **54.** Appropriate seals **39** and are utilized to position and seal the adaptor **36.** The lower adaptor portion **37** is preferably of an oval cross-sectional shape. A base plate **32** which can be made from Plexiglass is appropriately connected to the stepping switch base **30.** The cover **12** is appropriately recessed to permit a rotor connecting plate **38** and washer **40** to be located within the recess of the cover **12** and connected to the rotor **42.** A fastener **41** holds the rotor connecting plate **38** on the rotor drive shaft **34.** The rotor **42** is connected to the rotor connecting plate **38** by four circumferentially spaced screw members **60.** The connection of the rotor **42** with the flexible shaft **34** is only through the rotor connecting plate **38,** thus permitting a torsion bar spring flexing of the shaft **34** to aid in alignment and assembly of the switch. The rotor **42** is provided with, in the preferred embodiment, **12** longitudinal grooves **43** on the interior adjacent the cylindrical portion **31** of the base **30.** These grooves serve the purpose of providing lubrication and damping to the rotor movement.

The rotor body is stepped in its upper portion and provides a seat for a slip ring **44** preferably made from copper. The slip ring **44** is a cylindrical ring which provides a contact with the stud contact **22** of the terminal **14.** Slip ring **44** is connected to the rotor body **42** by four circumferentially spaced screw members **62** as shown in FIG. **2.** A connecting member **52** extends from the slip ring **44** to provide an electrical connection with a threaded brush member **50** which extends radially through the rotor body **42.** The brush member **50** can be brass and it contacts the contact plates or members **46,** likewise of brass, appropriately positioned in an internal flute **28.**

In preferred embodiment six incremental inputs of varying voltage from ground to a negative 20,000 volts are provided 60° apart through the cylindrical walls **24.** The contact plates **46** have a half cylindrical shape and are positioned in six of the twelve flutes **28** of the cylindrical walls **24.** Thus, the flutes **28** serve as positioning means for the bronze contact plates or members **46** as well as oil reservoirs.

On the outside of the cylindrical walls **24** are provided stand-off studs **48** defining input terminals which are made preferably of nylon to permit an electrical connection with the incremental voltage source. A screw member **58** threaded at it end is connected through a bore in the stand off studs **48** and cylindrical walls **24** to a threaded bore in bronze contact plate **46.** Screw member **58** is made of an electrically conductive material such as bronze or copper to allow electric current to flow from the incremental voltage source to the contact plate **46.** The rotor **42** is provided with semicircular circumferential grooves both above and below the threaded brush member **50** for the purpose of increasing the reservoir capacity of the stepping switch and for increasing the electrical leakage path to prevent voltage breakdown. The rotor is covered with a non-flammable oil to insure high voltage isolation between each of the input terminals as well as to provide a lubricating and damping function. An oil that has been highly successful is ASKAREL. This oil insures against a voltage arching between the various input terminals. It is clear that other forms of insulating liquid can replace the oil if it has the same electrical and non-flammable characteristics. The cover **12** and the cylindrical walls **24** are preferably sealed and air-tight to prevent deterioration and contamination of the oil.

In a preferred operation, the stepping switch is electrically connected to a high power tube with the output terminal **14** providing the input to the modulating anode which controls the voltage and current flow to a cathode. The stepping motor **54** revolves the self-aligning rotor shaft assembly to make the appropriate connections with the input terminal through the contact plates or members **46,** the threaded brush member **50,** the metal connecting member **52,** the cylindrical slip ring **44** and the stud contact **22** of the terminal **14.** The input terminals generally run in increments from ground to a minus 20,000 volts. The insulating aspects of the stepping switch provide both an increased electrical leakage path to prevent high voltage leakage and non-conducting insulating bodies comprised mainly of nylon with a non-flammable oil to isolate the appropriate voltage paths for each input terminal. While preferred material have been specified (for various components) it should be clear that substitutes are readily available that provide the electrical characteristics and ease of machining required in the present invention.

What is claimed is:

1. A rotary stepping switch comprising:
- a cylindrical housing having end closure means;
- at least one output terminal mounted on said end closure means and a plurality of input terminals mounted on said cylindrical housing
- a flexible insulated shaft means concentrically positioned for rotation in the housing;
- a rotor positioned concentrically within the housing means connecting said rotor to said flexible shaft means;
- a plurality of stationary contact members secured to the interior of the housing in circumferentially spaced relation and electrically connected to the input terminals;
- a slidable electrical connection means providing electrical contact between the rotor and the output terminal; and
- contact means on the rotor electrically connected to the sliding electrical contact means and adapted to contact the stationary contact means on the interior of the housing upon rotation of the shaft and rotor in proper angular relation relative to the housing.

2. A switch as in claim **1** further including a body of oil substantially covering the rotor.

3. A switch as in claim **2** where the flexible shaft means include a flexible shaft and an adaptor, the adaptor rotatably connected to the housing and the shaft, the shaft connected to the rotor.

4. A switch as in claim **2** where the sliding electrical contact means includes a slip ring mounted on the rotor and a stationary brush mounted on said end closure means.

5. A switch as claim **3** where the flexible shaft is plastic and the rotor is connected only at the end of the shaft farthest from the adaptor.

6. A switch as in claim 4 where the flexible shaft means includes a flexible shaft rotatably connected to the housing at one end and connected to the rotor only at the other end, the interior periphery of the housing being fluted.

7. A switch as in claim 6 where the rotor has a circumferential groove to increase the electrical leakage resistance of the rotor.

8. A switch as in claim 6 where the exterior of the housing has a circumferential groove to increase the electrical leakage resistance of the housing.

9. A switch as in claim 6 where the stationary contact members are positioned within the flutes of the housing.

10. A switch as in claim 6 where the housing has a stationary central cylindrical member with an axial bore, the flexible shaft rotatably positioned within the axial bore and the rotor having an axial bore positioned around the cylindrical member.

11. A switch as in claim 10 where the axial bore of the rotor has longitudinal grooves for lubricating and damping the relative movement of the rotor and the cylindrical member of the housing.

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