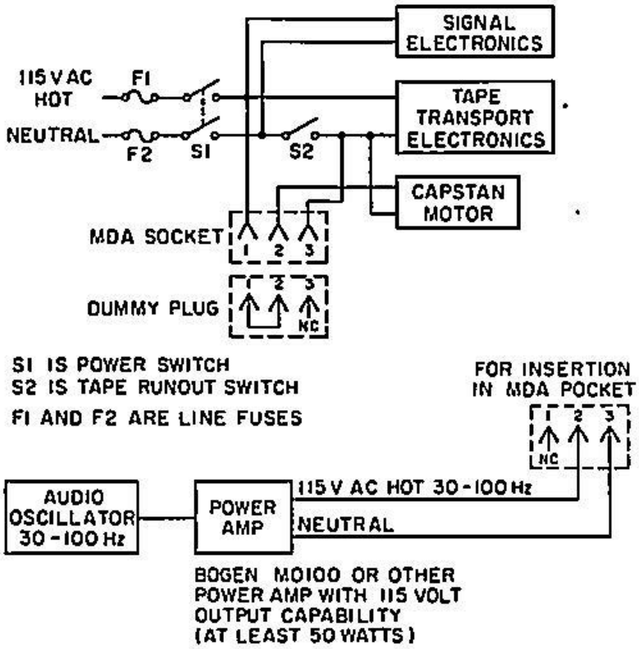

Figure 1. Removing the dummy plug from the mda socket.

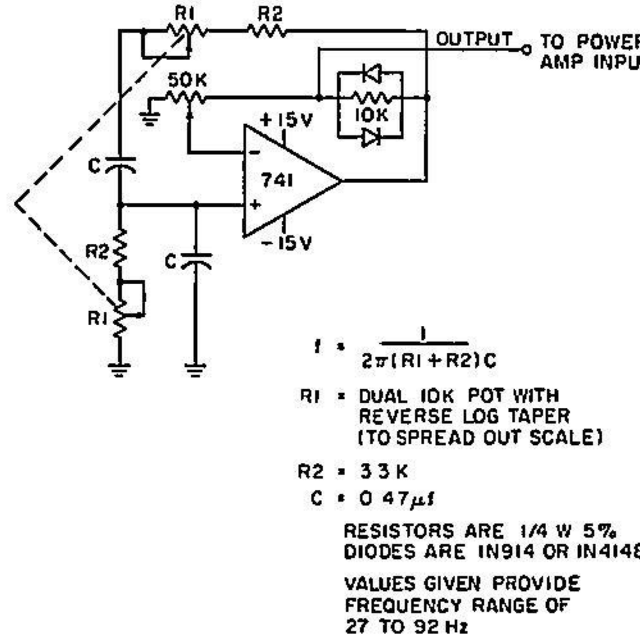

Figure 2. Design for an inexpensive oscillator.

ROBERT E. RUNSTEIN

A VSO Switichng System

Using electronics already present, the complications are taken out of connecting a variable speed oscillator.

CONNECTING A VSO (variable speed oscillator) is usually a bothersome task. It requires the connection of a variable frequency oscillator to a power amp capable of delivering 115 volts to its load, the use of a voltmeter to measure the voltage reaching the load while the oscillator output level is adjusted, and fumbling underneath a tape transport to remove the dummy plug from the mda (motor drive amplifier) socket so that a connector carrying the variable frequency power from the vso can be inserted (FIGURE 1).

The complexity of the situation arises from two causes. First, the output voltage from the power amp must be

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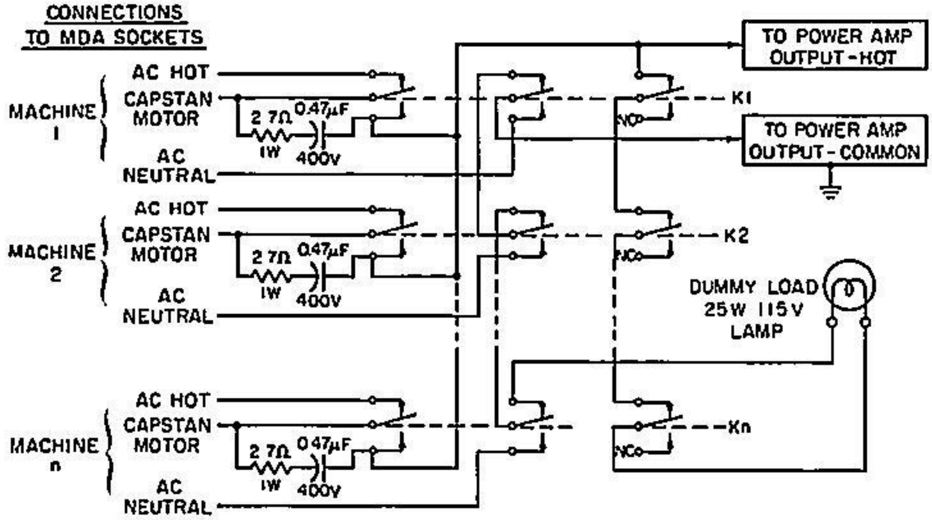

Figure 3. A switching system that automatically connects a capstan motor into a vso.

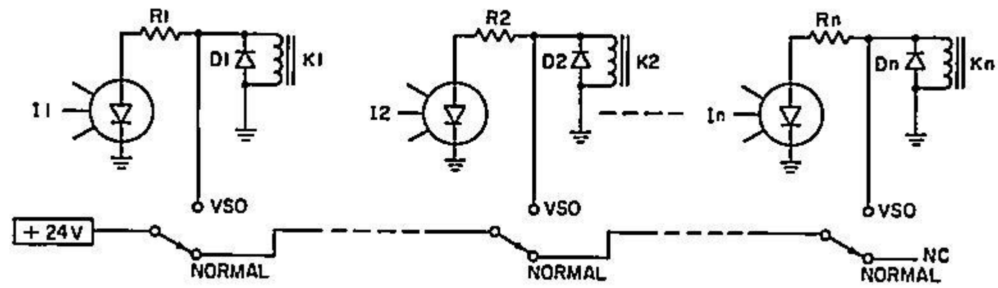

Figure 4. Using this circuit, the capstan motor will run whenever vso operation is selected, regardless of mode.

D1, D2, Dn = 1N4001
K1, K2, Kn = POTTER & BRUMSFIELD KHP 17D11 OR EQUIV (ONLY 3 POLES NEEDED PER MACHINE)
I1, I2, In = LEDs
R1, R2, Rn = SERIES RESISTOR TO CONTROL LED CURRENT

monitored so that the oscillator output can be set to provide the proper voltage to the motor While synchronous motors will operate at synchronous speed (their speed will depend on the *frequency* of the applied voltage) over a fairly wide range of voltages, too low a voltage may cause the motor to stall, while too high a voltage may overheat the motor windings and may also exceed the power amp output capability. That causes distortion of the waveform, which can result in speed irregularities Secondly, it is desirable to be able to vary the speed of any one of several machines at the flick of a switch without having to go to the expense of obtaining a separate power amp to drive each one.

The answer to the first of these problems is to allocate one oscillator to the vso system exclusively, and preset its output level so that the power amp delivers the proper voltage to the capstan motor. The oscillator need only be capable of limited frequency operation; most capstan motors will stall much below 25 Hz (less than ½ normal speed) and will reach maximum speed somewhere between 90 and 100 Hz (more than 1½ times normal speed). For smooth operation the oscillator should be capable of covering these frequencies without switching ranges, and with the high and low limits at opposite ends of the dial for good resolution Figure 2 is a design for an inexpensive oscillator which appeared in *Operational Amplifiers Design and Application*.[1]

The frequency of oscillation is determined by the formula $f = 1/2\pi (R_1 + R_2)C$ Resistors R_2 limit the oscillator's highest frequency to that which produces the highest tape speed—determined experimentally for the machines in use. If the oscillator frequency is permitted to exceed that frequency, slippage of the capstan motor's rotor can actually cause tape speed to slow down a bit. R_1 varies the frequency and should have a reverse log taper to spread the values out, but a linear taper will work adequately (settings above 60 Hz will be compressed into approximately the last 90 degrees of the control's rotation). R_3 is adjusted for minimum distortion, which occurs near maximum output before clipping. Distortion is on the order of 2 to 3 per cent, which is sufficiently low for this application.

SWITCHING SYSTEM

The answer to the second problem is the switching system to be described (Figure 3). The principle is simple. The vso is left on, driving a dummy load (a 25 watt standard light bulb) until variable speed operation is de-

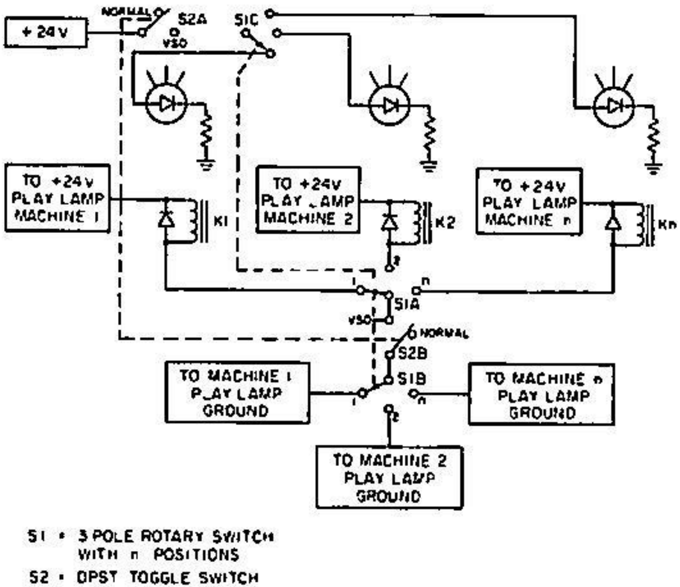

Figure 5. Substitute circuit, used if the tape machine stops capstan rotation when the machine is not in the play or record mode.

sired At that point, a relay disconnects the power line from the capstan motor of the desired machine and substitutes the output of the vso As many machines as desired may be wired into the system; the selection switch circuitry permits only one machine to be connected to the vso at a time The circuit illustrated in FIGURE 4 results in the capstan motor running whenever vso operation is selected, regardless of what mode of operation the tape machine is in.

The circuit illustrated in FIGURE 5 can be substituted if the tape machine is of the type in which capstan rotation is stopped when the machine is not in the play or record mode. Construction is straightforward, with the only complications being precautions in the wiring of the 115 volt vso circuitry (use at least #18 wire) and the avoidance of ground loops

The vso wiring is complicated by the fact that most tape machine manufacturers send only the high side of the a.c. line to the capstan motor through a jumper in the mda socket's dummy plug, leaving the low or neutral side of the line permanently connected. Thus, connection of the vso to the mda socket means that one side of the vso's output is connected to the a c power line neutral through the tape machine selected. Most power amp manufacturers connect the common side of the power amp's output transformer to the amp's chassis and therefore to the power line ground (if the unit is furnished with a three wire a.c. cord) or to one side of the power line through a capacitor (if a two-wire a c cord is used)

NECESSARY PRECAUTIONS

Given these conditions, the following precautions must be taken. The side of the output transformer connected to the power amp's chassis must be connected to the neutral side of the wiring to the capstan motor. If the power amp does not have a three-wire line cord which would assure that the common side of its output transformer is at ground (and therefore close to neutral) potential, the a c. plug should be rotated so that the side of the line connected to the chassis through the capacitor is connected to the neutral side of the power line The chassis of the power amp should then be grounded to the a.c. power ground. For additional protection, the power amp's two-prong a.c. plug should be replaced with a polarized three-prong plug which also provides a convenient point for the ground connection to be made.

Since it is common studio practice for tape machine a.c. power grounds to be left floating via the use of three- to two-prong a c. adapters to prevent ground loops, you must be sure that the two-prong end of the adapter is inserted into the wall socket in the proper direction If it is not, the connection labeled *neutral* on the mda socket will really be the hot side, and when the vso is connected to this machine, the hot side of the a.c. line will be connected to the a.c neutral through the tape machine's power switch and fuse, and through the power amp's chassis, causing the tape machine fuse to blow. Rather than risking this, the tape machine's power cord ground wire should be disconnected inside the machine so that the polarized three-prong a c. plug can be inserted directly into the wall socket, eliminating the possibility of blown fuses

The neutrals of the tape machine a c. lines must not be connected together by the vso switching system, for this may cause ground loops. The relays must therefore switch the neutral as well as the hot side of the vso power to the capstan motor selected, as shown in FIGURE 3.

NO CONNECTION BETWEEN CONSOLE GROUND AND POWER AMP

Since the power amp chassis is connected to the a c power ground, it is necessary that there be no connection between console ground and the power amp chassis, to prevent ground loops If the oscillator used has its own power supply (rather than operating from the console's d.c. supply) and its chassis is not electrically connected to the console via rack mounting or to a.c. power ground via its power cord, no ground loops will occur. When an oscillator powered from the console or electrically connected to the console in some manner is used, an isolation transformer will be needed to isolate console ground from the vso power amp chassis In the event either the oscillator output or the power amp input is already transformer-coupled and floating, that is sufficient if the cable to the power amp is shielded with the shield connected to the power amp chassis at that end and cut off at the oscillator end (telescoping shield).

Only one other item needs to be mentioned to prevent some head scratching when the system is connected. Some tape machine manufacturers insert the tape runout switch in the neutral side of the a c. line and wire the neutral connection on the mda socket to the transport electronics side of the runout switch (see FIGURE 1). As a result, when vso operation is selected, the power amp's neutral connection bypasses the tape runout switch, preventing automatic shutoff at the end of the reel. This is a small drawback when considering the many advantages of an easily implemented vso system. ■

REFERENCES

Tobey, Graeme, & Huelsman. *Operational Amplifiers: Design and Application.* McGraw-Hill Book Co., New York, N.Y. 1971. pp. 383-385.