Chuck Zappala WA7VZR
8051 NE 143rd Street
Bothell WA 98011

The Simplex Autopatch

— a telephone interface for everyone's two-meter rig!

Several local hams have been talking about a different kind of VHF autopatch that uses one frequency. This discussion has been going on from time to time over the past few years. We have designed many paper models of such a machine, with nothing more than a few beers as inspiration. But, in the August, 1978, issue of *73 Magazine*, there was a report of a machine built by John Walker WA6MHF in southern California. Well, needless to say, this sparked the discussion again, which this time actually led to construction.

For those of you who don't know what a single-frequency autopatch machine is or how one basically works, read on. Since most readers know what a traditional autopatch repeater is, let's start by explaining that it uses two frequencies (an input and an output), a duplexer (or similar device), and some control circuitry. Once the autopatch repeater is accessed, the transmitter is always transmitting and the receiver is always listening. Thus, two frequencies are used at all times.

Fig. 1. Complete hardware for simplex autopatch.

Using this method generally requires a duplexer to provide rf isolation between the repeater's transmitter and receiver circuits, in order to use one antenna.

The control circuitry provides the means to access the phone line, limits the length of the call, and terminates the patch.

The simplex method uses a single frequency, does not need a duplexer (unless you are in a very high rf environment), and requires slightly different control circuitry. The receiver is always listening on the simplex channel. When a signal is received and the appropriate tone command is received from the user, both the ON DIGIT and COR LINE enable a circuit to connect the phone line to the receiver and transmitter. At the same time, the transmitter is keyed on for 1.3 seconds and then off (in the receive mode) for about 40 milliseconds. What the user hears is dial tone from the phone line that is interrupted by "clicks" or the receive window. The user then keys his transmitter, and in less than 1.3 seconds (the time until the next receive window), the patch receiver will detect his signal (COR LINE) and inhibit the transmitter. The patch receiver is now locked in, listening to the user. The user then transmits his touchtone™ signals through the patch receiver to the phone line and on to the central office.

Local patch-control circuitry should check for local calling only and the length of the patch and dump the call if calling criteria are not met. Since this is not the purpose of this article, I will not go any further. When the user releases his transmitter button, the patch receiver responds by enabling the patch transmitter again in the same way as described previously. Thus the user can hear his call being processed (the called party's phone ringing and being answered). The user may talk to his party in a normal push-to-talk mode with the exception of the 1.3-second maximum delay and the "clicking."

Disconnecting the patch is simply a matter of the user keying his transmitter, pausing for the receive window, and signaling the disconnect code. The OFF DIGIT code also disables the patch transmitter from keying and locks the patch receiver in the receive mode.

The disadvantages to this method of autopatching are the "clicks" and the delay in speaking to your called party. The "clicks" are somewhat distracting to some and are quite tolerable by others. I found that with increasing use you can get used to the "clicking," and after experimentation, about 1.3 seconds was about the right speed to sample for a user's signal. Of course, you can set the speed to just about anything you feel is right, within reason. For example, trying to make the "click" shorter by narrowing the receive window less than 40 milliseconds depends on your transmitter-receiver switching time. Obviously, you should use a crystal-controlled receiver (synthesized receivers are much too slow, about 140 milliseconds). Also, the same applies for the transmitter as well. Another point is the method used to switch the antenna from receiver to transmitter. Relays are also much too slow because they add to the total switching transition. Rf detecting (diode switching) in the newer VHF radios works very well.

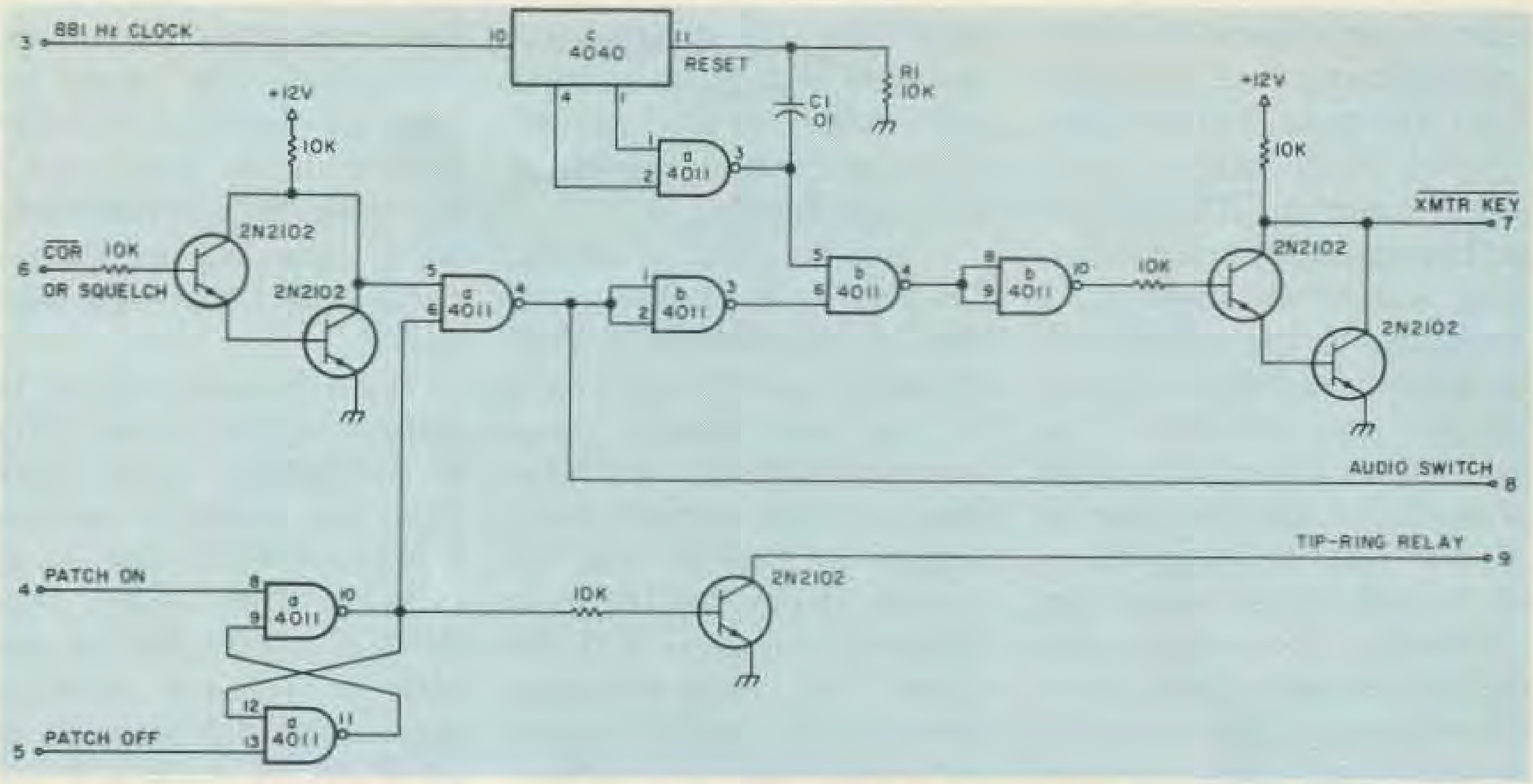

Fig. 2. Interface logic circuit.

The advantages are cost, simplicity, portability, and frequency conservation. Since there are no duplexers or similar rf plumbing, you save about $350 to $400. You don't need an expensive VHF radio such as a Motorola Micor (which a good repeater would use and costs over $1000). I used an Icom IC-22A, which was purchased used for less than $200. The modifications amounted to tapping the audio, the COR line, and the transmitter key. Later, I removed a 22-microfarad capacitor from the squelch dc amplifier to speed up the switching time. There are other modifications that could be made to improve the switching time, but I decided to study the present design before making any more changes. Since the VHF radio is small and can be run from a battery and there is no rf plumbing, the machine is very portable and has good emergency communications potential. All you need is a phone line, a quarter-wave whip antenna, and a single channel assignment.

The photograph shows the second breadboard version of the machine. The first version was a real rat's nest. Come to think of it, the second version has just as many wires going in every direction, but it works quite well. Ken Koster WA7RYP is one of the locals who worked on this project with me. Ken was eager to supply some vital circuits as well as his experience to make this machine work. Ken loaned me his Teltone™ M-907 touchtone decoder from his 450-MHz repeater. The decoder is about 4 inches long and 3 inches wide. It uses opera-

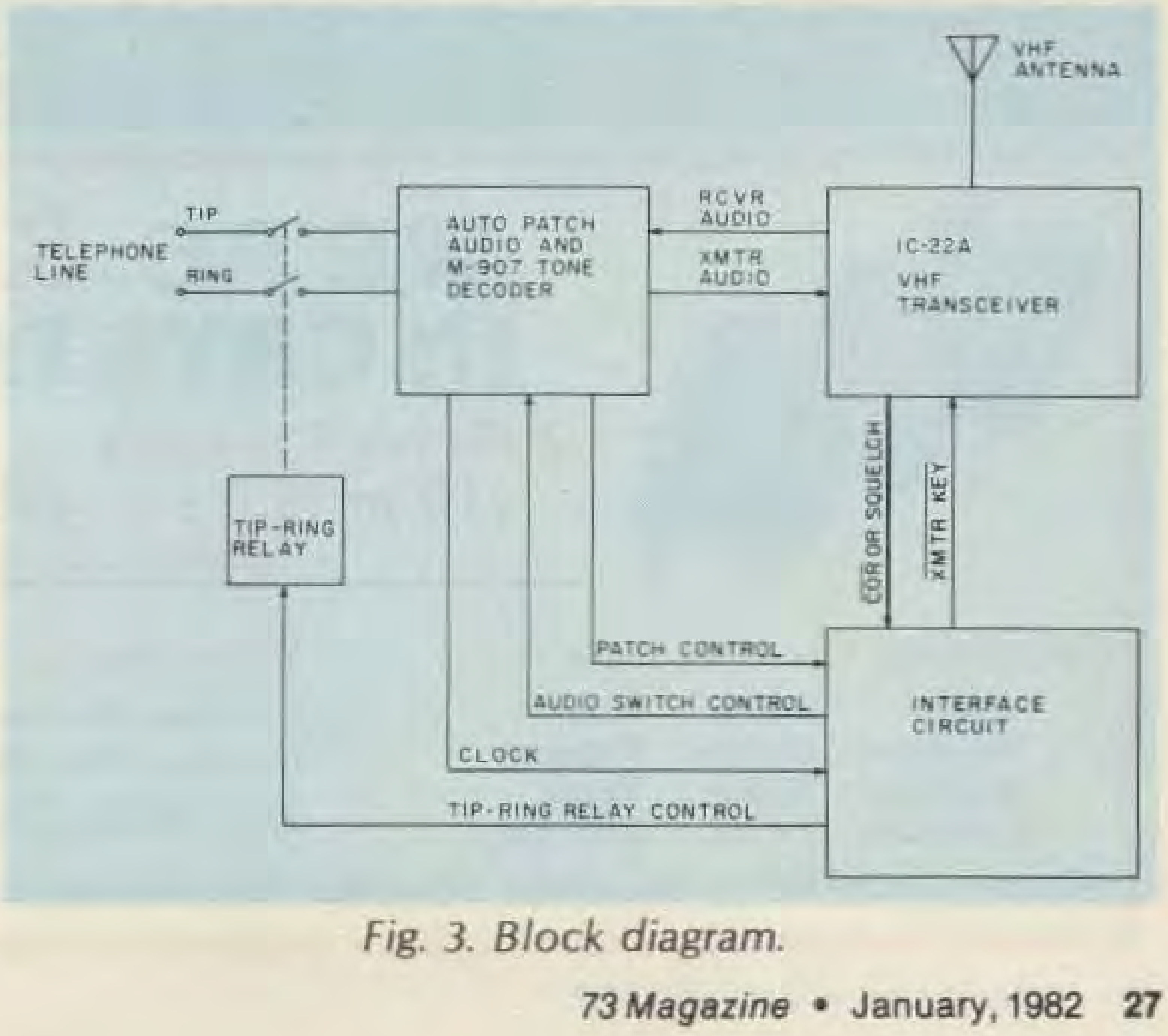

Fig. 3. Block diagram.

tional amplifiers for tone conditioning and a 40-pin LSI for tone verification, timing, digit output, and other functions. The decoder has an 881-Hz clock output which we used as a timebase to the control circuit for switching the transmitter and receiver. The unit costs about $85 and it mounts on another one of Ken's boards piggy-back style. Ken's main board also contains the autopatch audio and telephone interface circuitry. This circuitry is shown in the photograph in front of the Heathkit Digital Designer which contains the interface and control logic for the IC-22A.

After a few hours of blitz building, we had the second version ready for on-the-air tests. Using a Wilson Mark IV with a tone pad, Ken punched up the access, got the dial tone, punched up the local number, and there she was . . . the good ol' time lady. We dialed up a few ham friends for reports and made a few adjustments to the audio levels at the same time.

Later on that evening, Ken and I were talking simplex on the machine's VHF channel. I got this wild idea to call our friend Dave Miller WB5WCG in New Mexico! Ken topped it by suggesting that he dial the number from his location about 5 miles away. So I disabled the long-distance dump circuit and Ken started to dial Dave. A few seconds later, Dave was talking to Ken about our effort. A few short years ago, Dave was a local ham who was participating in our efforts for a single-frequency machine. Actually, he was surprised we finally did it. He knows that we dream a lot and that our fantasies seldom turn into connected silicon chips. During this live on-the-air conversation, Dave was giving his call and identifying the machine. The call lasted just a few short minutes, but when it was over, several hams who were listening in started calling the DX in New Mexico!

The schematic of the interface logic is shown in Fig. 2. An 881-Hz clock signal from the M-907 is used to clock a CMOS 4040 (a divide-by-4096 chip). The 4040 is configured to provide a receive window pulse every 1.3 seconds. By referring to a data book, you can easily change the sample rate and receive window pulse width. The output of the 4040 is NANDed and used to reset itself (the 4040). The value of R1 and C1 are not very critical. The 4011 latch gates the output of the COR Darlington transistor pair to allow the COR line to control the output of the 4040. The COR LINE and the 4011 latch control the transmitter keying line by using some 4011 NAND gates. A few transistors are used for the receiver COR and key line. The resistor values of these circuits are not very critical either. The transistor Darlington circuits may require some changes for the specific radio they are to interface. Fig. 3 illustrates a block diagram of the machine. The audio circuits interface the radio to the phone line and the tone decoder.

Remember, this machine is not a repeater and cannot be used to contact another ham via a downlink radio path. The machine can only transmit what it hears from the phone line and send to the phone line what the patch receiver hears. I would be interested in hearing from anyone who knows about any similar efforts or any improvements. Please, SASE letters only. ■