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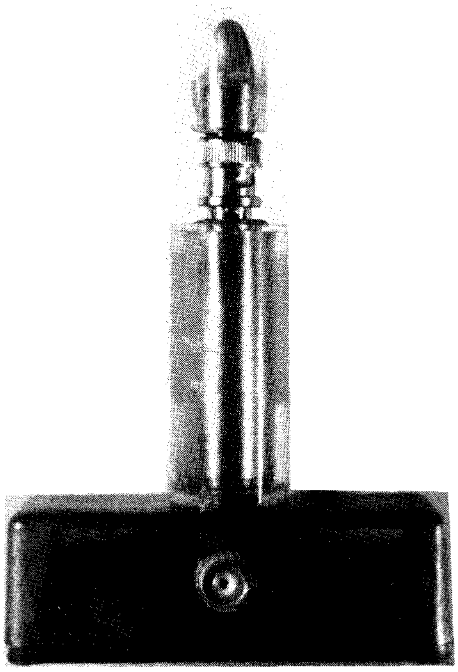

FIG. 2. Photograph of the feedthrough with a probe attached.

tached probe without breaking the vacuum). Its length is chosen to allow a limited amount of reentrant motion, while keeping the twin connector isolated within the seal housing and thus outside the main volume of the vacuum chamber. The rod is bored out to clear the center conductors and shield with vacuum sealing accomplished by potting the conductors in place with a commercially available epoxy.[5]

The assembled feedthrough and probe, shown in Fig. 2, has been used in systems operating below 10^{-6} Torr. Applications for this feedthrough are not restricted to any one type of probe. It may be used with many interchangeable two- and three-lead probe configurations, depending on how a particular probe's twin connector[6] is wired, with the signals fed to one or both of the BNC connectors outside the vacuum.

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[5] Shell 815 Epoxy.
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Tuned limiter for receiver amplifier in a fast-recovery pulsed NMR spectrometer

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A simple tuned limiter is described which limits the rf voltage amplitude at the input of the receiver amplifier of a pulsed NMR spectrometer. This device prevents overload of the receiver amplifier during the high-power rf pulse and thereby allows fast recovery of the spectrometer following the pulse. When used with Avantek unit amplifiers at 24 MHz, a recovery time of 2.5 μs is achieved.

A major problem of pulsed NMR in solids is the recovery of the receiver amplifier following a high-power rf pulse. Often one must be able to detect and measure a free-induction-decay signal within a few microseconds following the pulse. To solve this problem, one either uses an amplifier[1,2] which recovers quickly from overload or one somehow limits the rf at the input of the amplifier during the pulse to *prevent* an overload condition. This latter solution requires some kind of active gate[3–5] or passive limiter.[6]

In this note, a passive tuned limiter is described which is simple in design, limits very effectively, and has a very small insertion loss. Since the limiter is passive, no external timing circuitry is necessary, as is required for active gates. (The author is aware of only one other passive limiter reported in the literature,[6] which, however, has a high insertion loss of 6 dB.) Because the limiter prevents overloading of the amplifier, we are free to use an amplifier which doesn't meet the otherwise stringent requirement of fast recovery from overload, thus widening the choice of commercially available rf amplifiers for use in a pulsed NMR spectrometer.

The tuned limiter consists of a series-tuned inductor L and capacitor C with crossed diodes to ground between them (see Fig. 1). The resistor R at the output represents

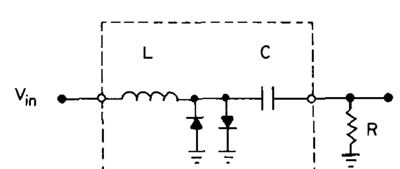

FIG. 1. Tuned limiter. L and C are series tuned to the NMR frequency. R represents the resistive load of the rf amplifier input.

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TABLE I. Performance of the tuned limiter (see Fig. 1) with L and C series-tuned at 24 MHz and with $R = 50\ \Omega$. The insertion loss was measured under small signal conditions (no limiting). The limit of V_{out} was measured with $V_{in} = 1$ V peak to peak.

C (pF)	Insertion loss (dB)	Limit of V_{out} (mV peak to peak)
5	2.8	76
10	1.3	140
20	0.6	210

the resistive load of the amplifier input (e.g., 50 Ω). For large V_{in}, the crossed diodes to ground limit the rf amplitude between the inductor and capacitor to a voltage V_D. The capacitor and resistor thus form a voltage divider, and V_{out} is limited to ωRCV_D (assuming $\omega RC \ll 1$), a factor ωRC better than crossed diodes alone. (Note that crossed diodes to ground are commonly used in pulsed NMR spectrometers to *protect* the receiver amplifier, but, used alone, they do not prevent overload.)

For small values of V_{in}, the diodes do not conduct, and the L-C pair presents a low impedance, resulting in $V_{out} = V_{in}$. For large L/C ratios, resistive losses in the diodes give rise to an insertion loss. Thus, one must choose optimum values for L and C such that the L/C ratio is large enough to effectively limit the rf amplitude during the pulse but not so large that the insertion loss is intolerable. Table I shows the measured performance of the tuned limiter at 24 MHz for three different choices of C.

The tuned limiter was tested in a receiver amplifier consisting of three Avantek[7] unit amplifiers, each preceded by a limiter tuned at 24 MHz (see Fig. 2). The insertion loss of the front-end limiter was 0.6 dB which accordingly increased the noise figure of the amplifier by that amount. The performance of the receiver amplifier was tested in a standard pulsed NMR spectrometer

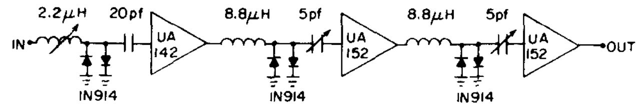

FIG. 2. Receiver amplifier using limiters tuned at 24 MHz and Avantek unit amplifiers UA 142 and UA 152.

(such as the one described in a previous paper[8]) where a dummy 50-Ω load was substituted for the sample probe. The recovery time of the spectrometer was measured to be 2.5 μs. Removing the front-end limiter increased the recovery time to 5.5 μs. Thus, one could obtain a better noise figure with only a little sacrifice in recovery time. With all the tuned limiters removed, the recovery time of the spectrometer was between 20 and 50 μs (depending on the length of the rf pulse), thus showing the usually poor recovery characteristics of these Avantek unit amplifiers. This receiver amplifier (as shown in Fig. 2) has been successfully used in pulsed NMR measurements where, using a low-Q sample probe ($Q \cong 13$), a recovery time of 3 μs was obtained.

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"Wonderstone" ENDOR cavity

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We report the design and construction of a high-quality ENDOR cavity from a naturally occurring rock, "Wonderstone." It consists of a cylindrical cavity operated in the TE_{011} mode, with four vertical posts forming the ENDOR coil. 100 kHz field modulation is achieved by external coils mounted on the pole faces of the magnet. This cavity is especially suited for the insertion of a cold-finger Dewar. The merits of Wonderstone as a substrate material for microwave cavities and the details of obtaining a fine conducting layer of silver on the inner surface of the cavity are discussed.

Many controlled skin-depth cavities have been described in the literature.[1–7] They all involve a substrate which supplies the mechanical strength, and a thin coating of silver, copper, or gold to control the electrical properties. Three types of substrates are commonly encountered: (1) high resistance metals or alloys such as stainless steel and nickel–silver, (2) inorganic dielectrics such as quartz, ceramic, and glasses, and (3) organic dielectrics such as epoxy compounds. In this connection we have used a material called "Wonderstone,"[8] which

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