CHANNEL MULTIPLEXER FOR A MILLIMETER WAVEGUIDE TRANSMISSION SYSTEM

By

T. A. Abele
Bell Telephone Laboratories, Incorporated
North Andover, Massachusetts, 01845

This paper describes development work done to date on a channel multiplexer network for a millimeter waveguide transmission system capable of carrying almost 250,000 telephone conversations. There is great interest in this means of transmission throughout the world and the multiplexer to be described is part of a system currently under exploratory development at Bell Telephone Laboratories.

The key to this system is the TE_{01} mode of propagation in circular cylindrical waveguide. This mode provides low loss transmission over wide frequency bands, a fact known for over 35 years. Only recently, however, has technology advanced far enough and telephone traffic is growing fast enough to make exploitation of this phenomenon appear economically attractive. The concept of this system has been described at previous conferences during 1970.[1,2]

Since each channel requires a separate regenerative repeater, two units of a 1 to 120 port multiplexer are required in each manhole to connect between the 120 repeaters and the two waveguides leaving the manhole. Figure 1 shows this arrangement as it is presently envisioned. The multiplexer is seen to contain three basic components, (1) "band diplexers" to subdivide the 40 GHz to 110 GHz frequency band into "sub-bands", (2) "channel diplexers" to single out the individual channels from the sub-bands, (3) "low pass filters" to provide additional selectivity to that of the band diplexers.

The band diplexers will be realized in the familiar Michelson-type interferometer structure shown in Figure 2. The selectivity of these diplexers will be chosen such that the transition from a 20 dB isolation between ports 1 and 2 to a 20 dB isolation between ports 1 and 3 will take place within 600 MHz. Therefore, the bandwidth of only one channel has to be sacrificed as guard-band between adjacent sub-bands. We are expecting intrinsic losses (due to mode conversion) for the diplexers to range from 1.8 dB at 40 GHz to 0.8 dB at 110 GHz.

The channel diplexers are second order complementary bandpass bandstop filter pairs with a 3 dB bandwidth of 500 MHz (maximally flat loss). Three realizations, all based on similar principles, are presently being studied (Figure 3). The expected intrinsic losses for the three structures are quite different, however, ranging from .2 dB at 40 GHz and .6 dB at 110 GHz for the structure of Figure 3a to .8 dB and 2.8 dB, respectively, for the structure of Figure 3c.

The low pass filters will be realized by a yet to be determined combination of the structures shown in Figure 4. These include (a) a terminated band diplexer, which again operates properly only for the TE_{01} mode, and (b) a dielectric disc filter, which is essentially mode insensitive and reactive, hence capable of providing high stop band loss. Consideration is also being given to a leaky wave type filter, which would be mode insensitive and lossy, but only capable of providing rather moderate stop band loss.

References:

1. I. Welber - "A Millimeter Waveguide Transmission System" - IEEE International Convention and Exhibition, New York, N.Y., March 1970.

2. P. T. Hutchison - "A Digital Millimeter Wave Waveguide Transmission System" - IEEE Conference on Trunk Telecommunications by Guided Waves, London, G. B., September 1970.

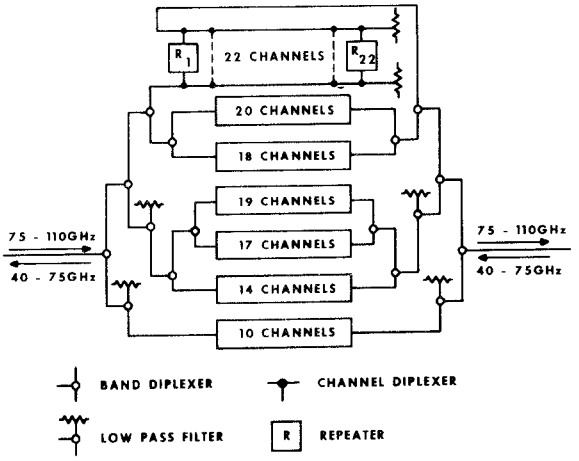

FIGURE 1

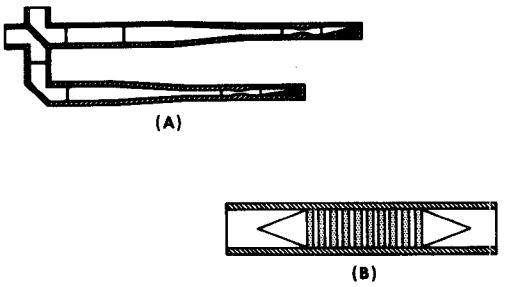

FIGURE 4

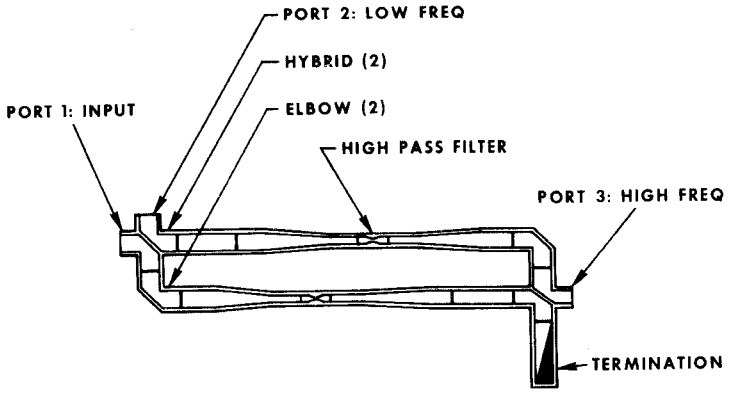

FIGURE 2

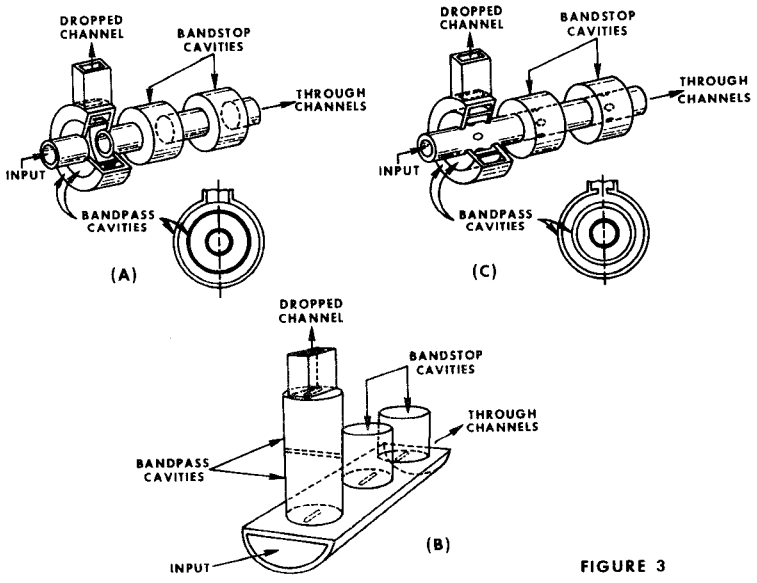

FIGURE 3