April 30, 1997

INTERCONNECTING SIGNALS WITH FIBER-OPTIC CABLE

As experienced is gained with fiber-optic cable, and as the price continues to drop, it is quickly becoming the "medium of choice" for interconnecting traffic signals. Correspondingly, multi-pair copper wire and coaxial cable are being used on a less frequent basis. The advantages of fiber-optic cable include:

1. **High Bandwidth** - This characteristic allows each fiber to carry a huge amount of data, which is important for advanced traffic applications such as transmitting real-time video.

2. **Small Diameter** - The fibers are very thin and many fibers can be incorporated into a cable having a relatively small diameter. Since smaller cables are easier to pull than larger cables, pull boxes can be spaced at greater distances. A distance between pull boxes of up to 1000 feet is not out of the question with small fiber optic cables.

3. **Non-Conductive** - Since the fibers are made of glass and since the cable jacket contains no metallic materials (non-metallic Kevlar braiding is typically used to supply tensile strength for the cable), the cable does not conduct electricity. This can be an important plus in states like Florida where destructive high voltage transients caused by lightning strikes sometimes enter the cabinet via the interconnect cable.

4. **No Interference** - Fiber optic cables do not produce electromagnetic radiation and they are not sensitive to such radiation given off by other cables. Consequently, they can be freely mixed with other cables in the same conduit and pull boxes whereas other communication cables require separate facilities.

5. **Long Transmission Distance** - There are two basic types of fiber optic cable, multi-mode cable and single-mode cable. The primary operational difference between these two cable types is that light signals sent over single-mode cable typically emanate from a laser beam whereas multi-mode cables tend to use light from LED's (Light Emitting Diodes). The laser generated light can travel for many miles through a single-mode fiber without the need for regeneration whereas an LED signal in multi-mode fiber has a limited range of around a mile. Although multi-mode systems used to be much cheaper than single-mode systems, the price gap between the two continues to close. The cost of a single-mode system is becoming more and more competitive and many agencies are now favoring such systems.

There are precautions that must be followed when using fiber optic cables. These cables are somewhat fragile and cannot be roughly treated without shattering the fibers. Driving over them with a truck, "kinking" them around a corner, or forcing them through a tight opening - actions that might not hurt a copper cable - will probably ruin one or more fibers in a fiber optic cable. And the really bad part is, unlike copper, you can't tell that the cable is ruined by just looking at it. The bad news won't surface until testing of the installation begins.

Unless you have a cable with a high number of fibers, most fiber optic cables having a minimum bending radius of about 9 inches. This suggests that, if you intend on providing spare cable within a pull box (which is a good idea for both expansion and repair reasons), then the box must be large enough to accommodate loops of cable that are 18 inches in diameter. For this reason, many agencies specify the use of large pull boxes (36" long by 24" wide by 18" deep) with fiber optic cable.

However, large pull boxes are expensive and require a fair amount of space. Therefore, instead of requiring that every pull box be a large one, another option is to use large pull boxes only at controller cabinet locations with standard pull boxes (24" long by 12" wide by 12" deep) used elsewhere. The large pull boxes will contain the loops of spare cable while the small pull boxes are used for pulling purposes only. As shown in Figure 1, by angling the conduits that enter the standard pull box, a 9-inch minimum bending radius can be maintained.

Once the conduit system is in place, a warning tape should be buried a foot or two above the conduit so that future excavators will be warned of the cable's presence. This warning tape should be detectable (having a small metal wire running through it) so that, in the future, the position of the conduit can be located with metal detection equipment.

Once the fiber optic cable enters the controller cabinet it is a good idea to terminate it in a special wall-mounted enclosure designed for that purpose (see Figure 2). Fiber-optic jumpers with ST connectors can then be used to connect the end equipment, such as the controller, to the enclosure. This is done in a plug-in manner similar to the way stereo speakers are connected to a receiver.

Fiber optic cable is tying the world together and its increasing use in traffic signal systems should come as no surprise.

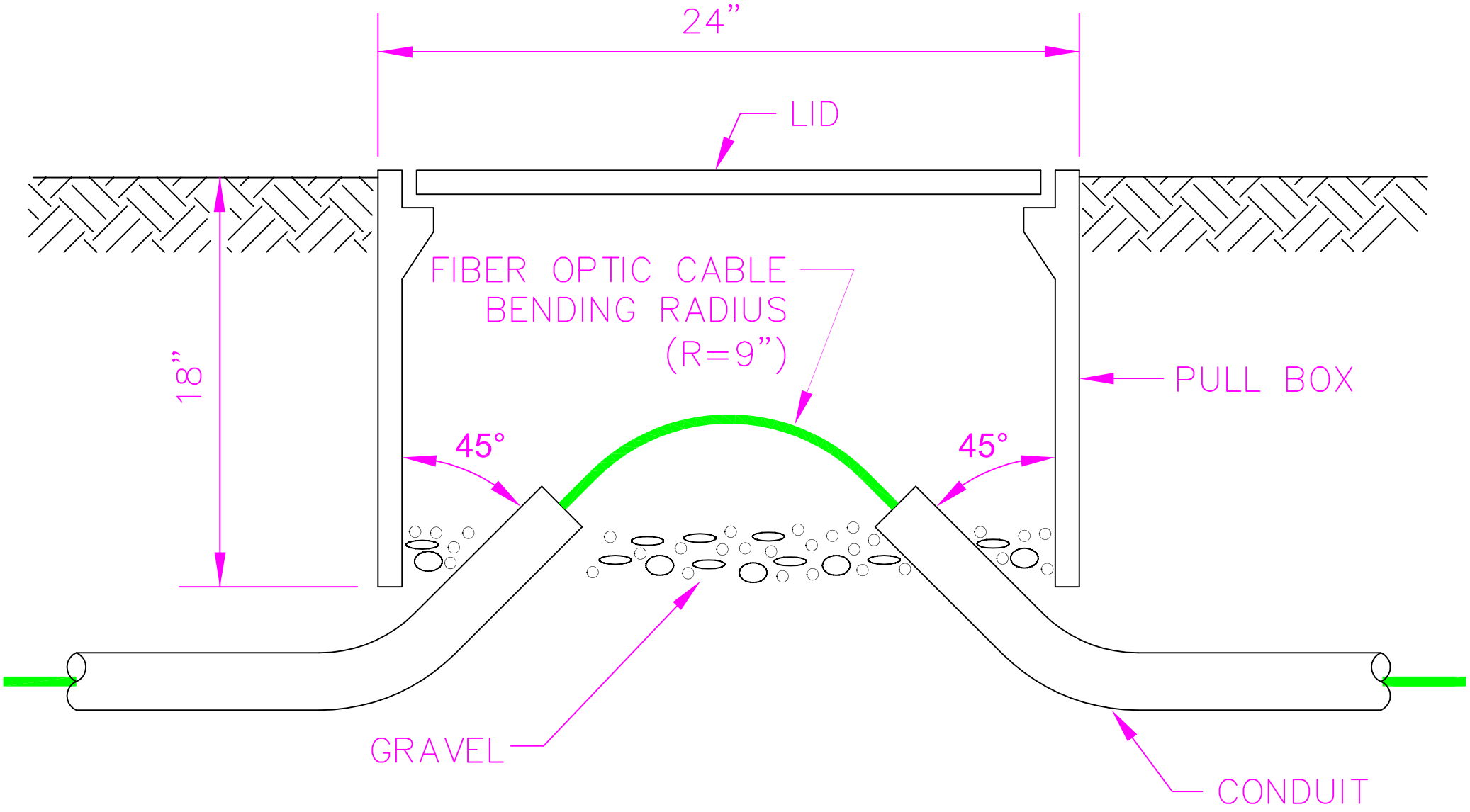
24”
LID
FIBER OPTIC CABLE
BENDING RADIUS
(R=9”)
18”
PULL BOX
45°
45°
GRAVEL
CONDUIT

FIGURE 1

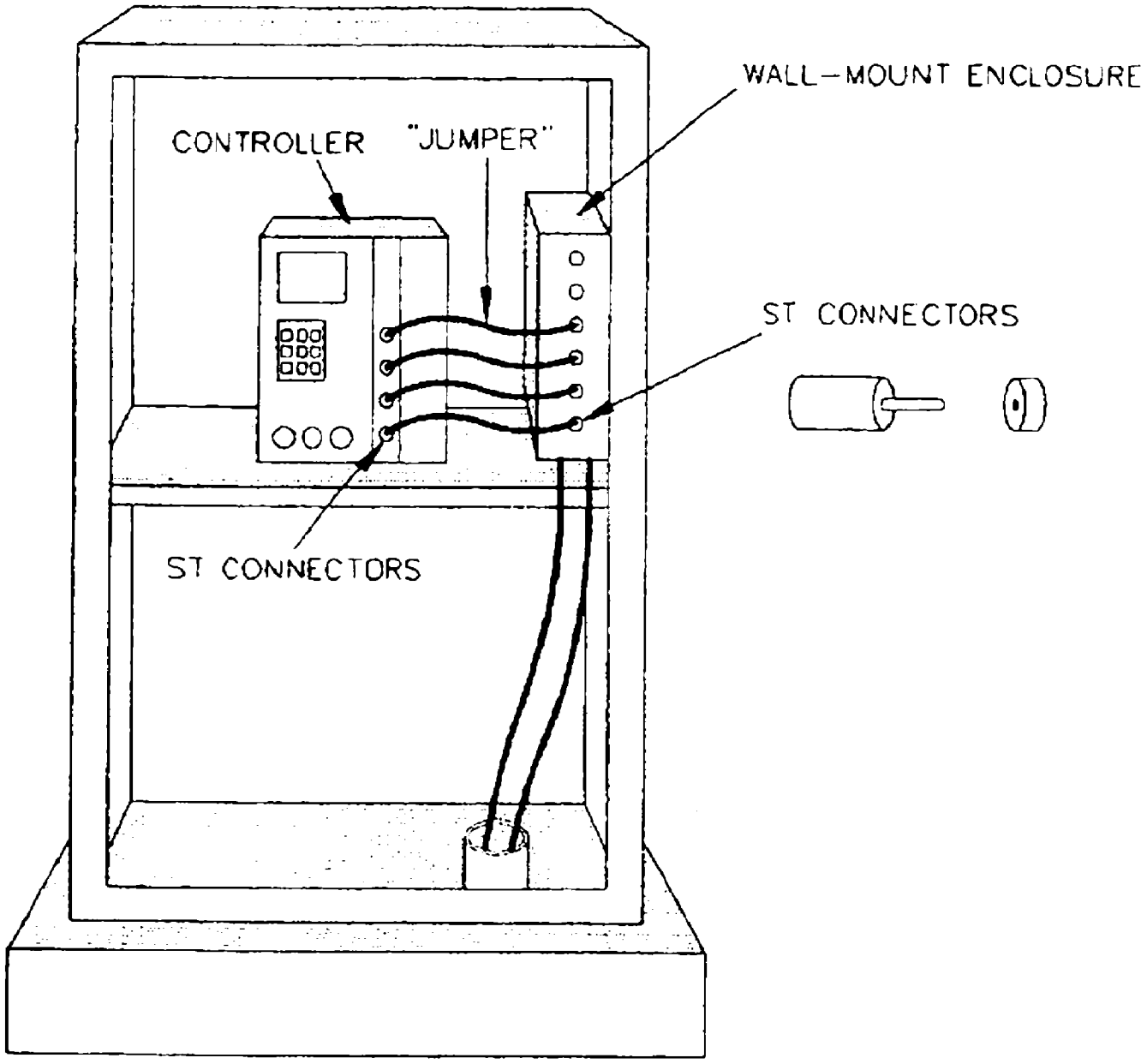
WALL-MOUNT ENCLOSURE
CONTROLLER
"JUMPER"
ST CONNECTORS
ST CONNECTORS

Fig. 2