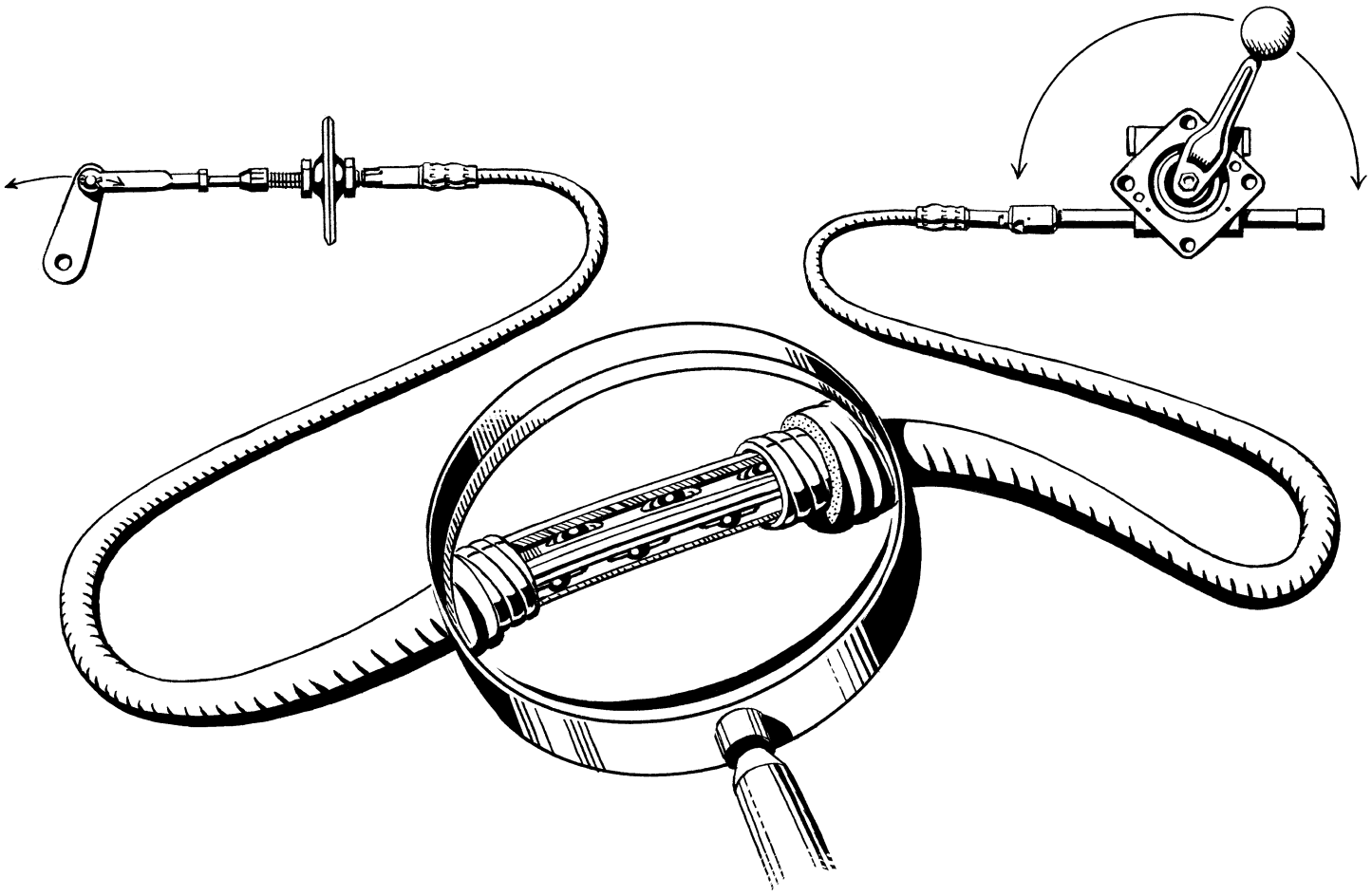
Flexball®



IMPORTANT!
PLEASE READ THIS BEFORE UNPACKING OR INSTALLING.

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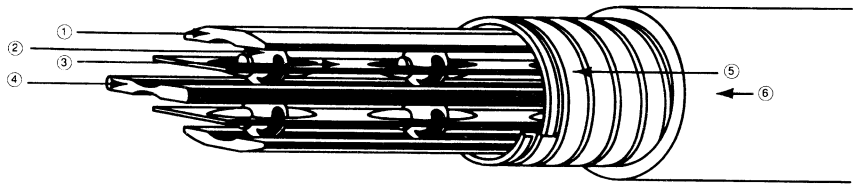
HANDLING & INSTALLATION INSTRUCTIONS

Introduction:

The **Flexball®** control cable assembly **is not an ordinary Bowden wire cable**! It is in fact a linear ball bearing. See Figure 1 below. When properly installed for appropriate applications, **Flexball®** will give the maximum degree of transmission efficiency and ease of movement available from a mechanical control system.

Because **Flexball®** is a precision instrument it is **essential** that its handling and installation are carried out according to the following procedures. **Failure to do so could void the manufacturer's limited warranty.**



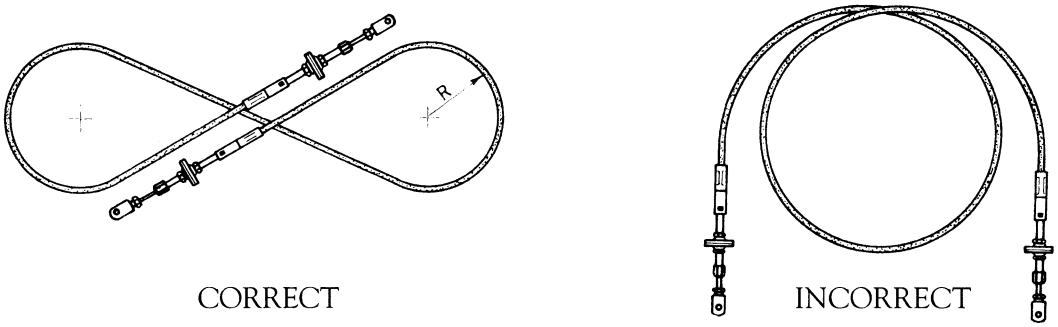
① Stainless steel outer rail (carries reactive loads)
② Free floating stainless steel balls
③ Stainless steel ball cage (positions balls for optimum performance)
④ Stainless steel center rail (active load transmitting element)
⑤ Flexible interlocking steel casing (provides radial support)
⑥ PVC cover (protects inner working elements from outside contamination)

Figure 1

Shipping & Storage:

Depending on their length **Flexball®** control cables are wrapped for shipment in either a "figure 8" or "U" shape. If they are not going to be installed immediately after receipt they should be left in their boxes until they are needed.

Under no circumstances should **Flexball®** be forced into a coiled condition as this may permanently damage the interior elements of the cable. Figure 2 below shows the correct and incorrect methods of wrapping **Flexball®**.



CORRECT INCORRECT

Figure 2

Initial Handling:

When unwrapping **Flexball®** the following steps should be followed:

1. Lift the control cable from its box, hold it upright in both hands and cut the plastic cable tie at the center of the "figure 8." Be sure to keep a firm grasp on all the sections of the cable that intersect at the center of the "figure 8."

2. Starting with the end fitting nearest you, pay out the loops of the cable, one at a time until the cable is laying out straight. See Figure 3 below.

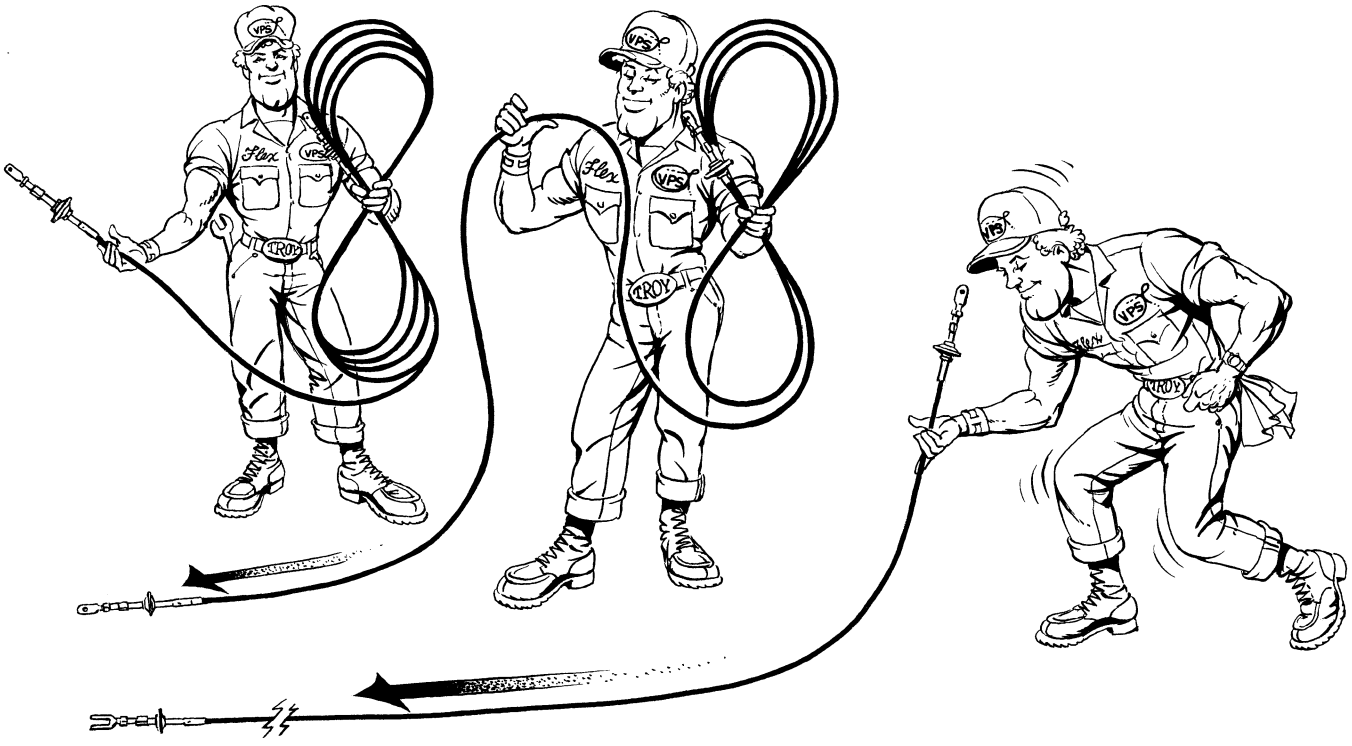


Figure 3

Bend Radii:

The following minimum bend radii should be adhered to when handling or installing **Flexball®**:

	Type 78	Type 98	Type 128
Occasional Cycling:	4.00 in.	5.00 in.	8.00 in.
Continuous Cycling:	12.00 in.	15.00 in.	20.00 in.

Installation:

With long cables it is important to remove any inadvertent helixes which might have developed during unpacking. This is accomplished by placing the hands under the flexible section of the control cable near one of the ends and establishing a slight "hump." Then run this "hump" along the entire length of the control cable so that finally it is laying flat and straight on the floor. See Figure 4 below.

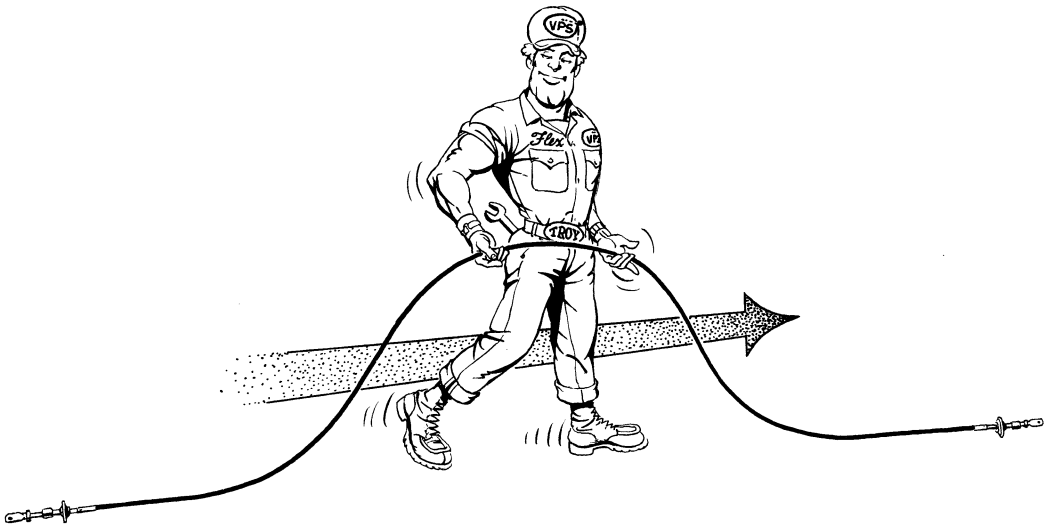


Figure 4

Bending Limits - A major point to keep in mind when installing **Flexball®** is that whenever it is bent, the three internal rails will form concentric arcs. Therefore, either the outside outer rail must increase in length or the inside outer rail must shorten in length to compensate for the different radii of each rail's arc. (See Figure 5)

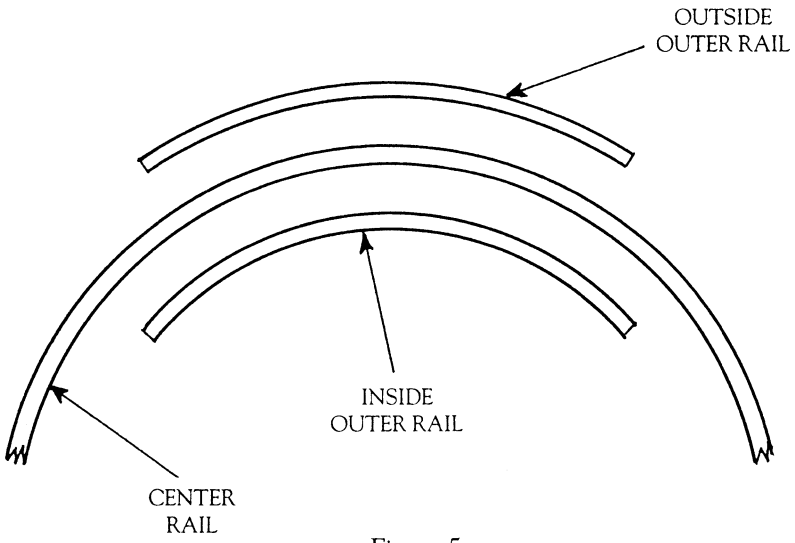


Figure 5

This requirement is met by an internal rail anchoring system which allows both outer rails to carry reactive loads and compensate for bending.

While **Flexball®** can be bent a little over 180 degrees in either direction, any number of bends can be accommodated during installation so long as the difference between the total number of opposing bends does not exceed 180 degrees. Should a particular routing require a bend in excess of 180 degrees in one direction, it can be accomplished by helixing the rails. (See below.)

Three Dimensional Plane Orientation

Routing **Flexball®** through complex three dimensional configurations is accomplished by helixing the control cable's internal components (i.e. the rails and ball guide strips). The cable has a high degree of torsional deflection (55 degrees per linear foot) which facilitates its routing over different bend planes. Allow sufficient straight length for the cable to helix between bend planes. (See Figure 6.)

As noted above, helixing the rails also allows the cable to exceed the 180 degree one-way bend limitation in one plane.

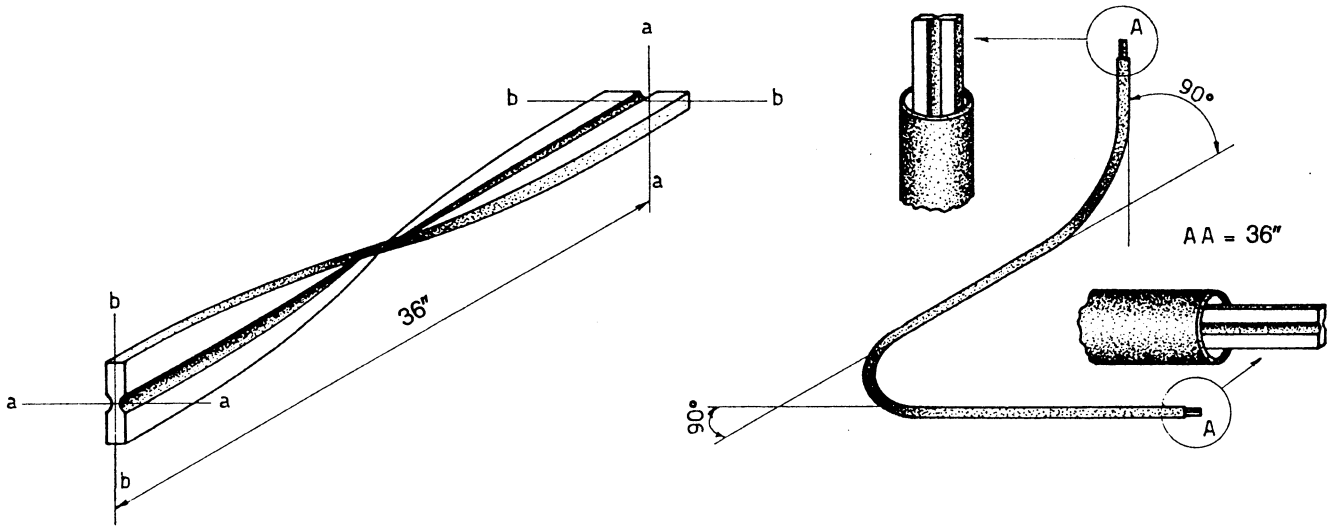


Figure 6

After unwrapping **Flexball®** and removing inadvertent helixes, installation can begin. It is recommended for control cables over 10 feet in length that at least two persons are employed in the installation. Figure 7 (next page) illustrates how one person holds one end of the cable in a moderate loop while the other person or persons snake the cable into its approximate position.

It is important to route the control cable completely before attempting to anchor the end fittings. Anchoring one end before routing the cable usually results in having to overbend or otherwise abuse the cable in order to install it. It is important to remember never to force Flexball® into a bend, but rather to guide it into a natural configuration.

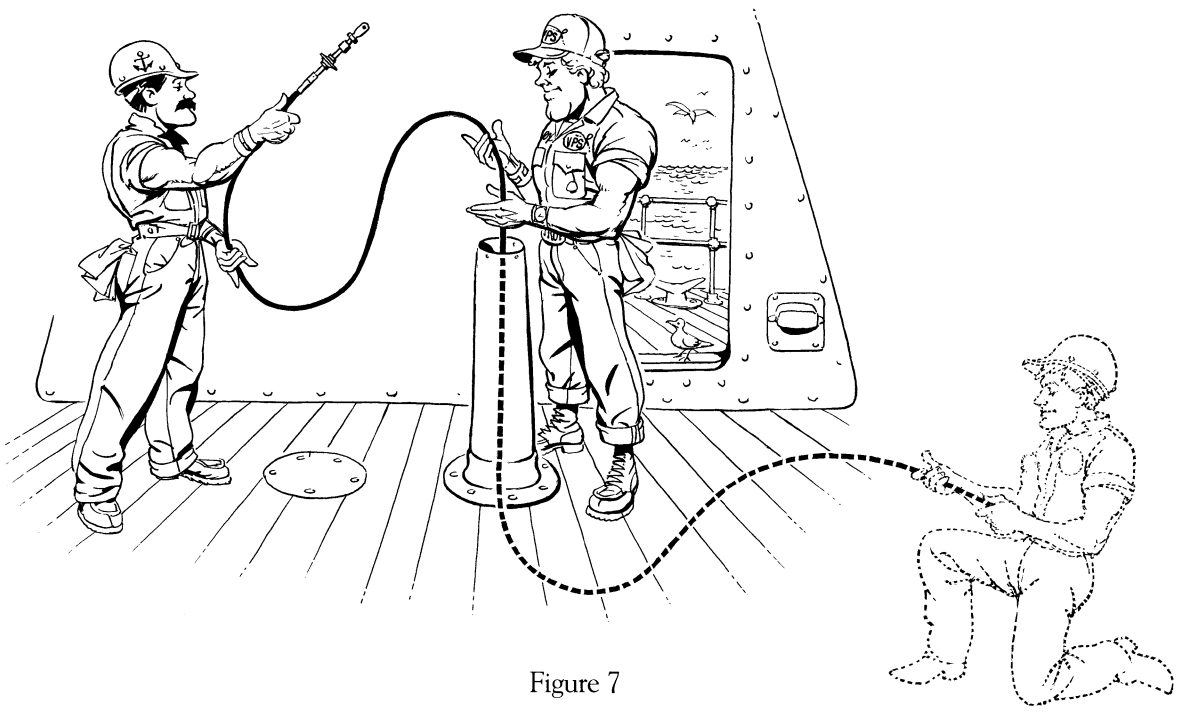


Figure 7

System Check Out

After the control has been routed, the mounting sleeves can be loosely fastened and the end rod stroked to be sure there is no binding. At this point, **Flexball®** should stroke just about as freely as when it was laid out straight prior to installation. Should excessive or erratic force be required to stroke the cable, an error has been made in the routing. Carefully remove **Flexball®** from the installation and begin again.

Once it is established that the control cable is stroking freely, permanent mounting clips can be placed along the route wherever necessary. (Spaced every 18 to 24 inches according to the routing requirements.) **IMPORTANT: Be sure such clips do not pinch the flexible conduit or force the control cable out of its natural routing.**

Once again check to be sure **Flexball®** is still stroking freely (see Figure 8).

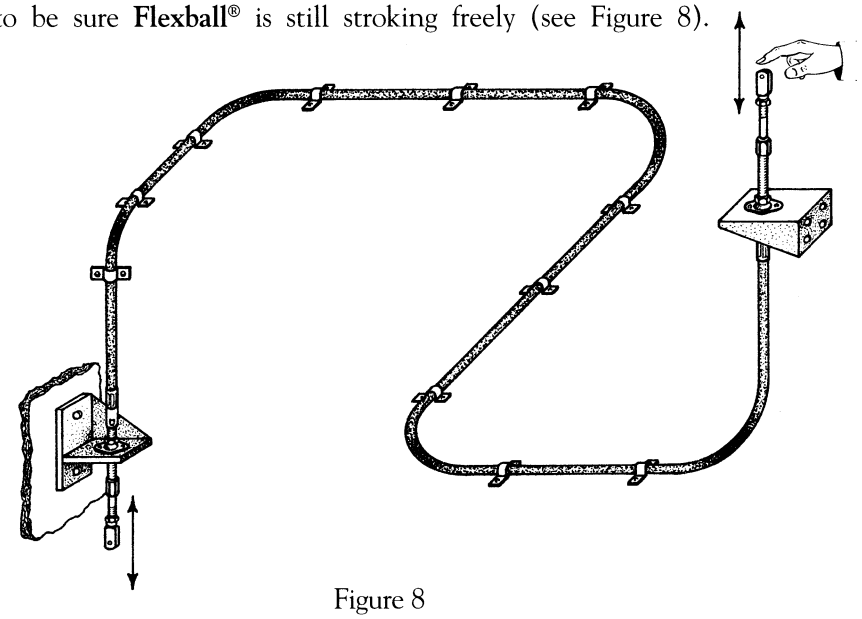


Figure 8

End Fitting Connection:

If either control cable end is going to be attached to a lever, compensation for the lever arc must be made by using either a spherical mounting bearing (swivel abutment) on the main sleeve, a linear ball joint on the end rod, or a swivel tube end fitting. (Note: A swivel abutment, ball joint, or swivel tube end may also be used for straight push-pull applications to compensate for any misalignment.)

Swivel Abutment (Figure 9):

When attaching to a lever, the end fitting connection should be such that the control cable bend plane is the same as the oscillating lever plane. The end fittings should be free from lateral binding.

Place the swivel abutment as far back on the main sleeve as the thread permits in order to minimize the angle of articulation. Allow some thread for stroke adjustment. The center of the hole in the mounting bracket for the swivel abutment should be positioned so as to split the articulating angle. **IMPORTANT:** This angle should not exceed ± 8 degrees either side of center.

Adjustment, if required, may be accomplished by adjusting the position of the control main sleeve or at the end rod thread. Do not twist the end rod while performing adjustments or fastening jam nuts; use a proper size wrench to secure the end rod at the wrench flats.

For this application, the flexible portion of the control cable should not be bent close to the anchor sleeve. The flexible straight length behind the anchor should be equal to the cable's stroke or longer, with a minimum of not less than 3.00 inches.

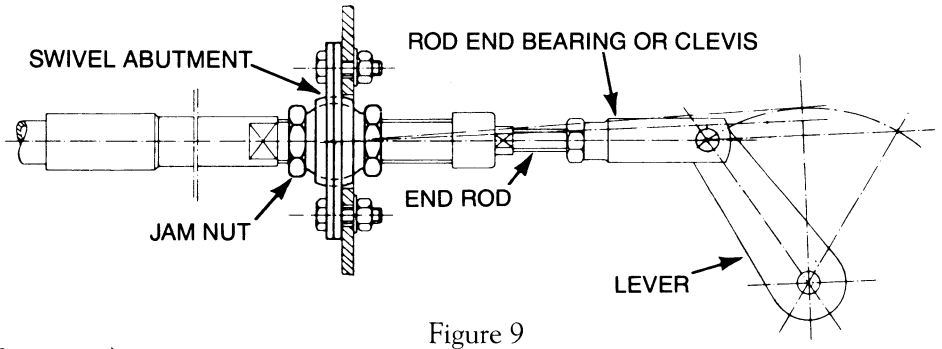


Figure 9

Ball Joint (Figure 10):

The axis of the cable's main sleeve should be midway between the high point and the low point of the lever arc. This insures equal articulation of the ball joint and uniformity of forces and stroke.

Mid-position of the lever travel should coincide with the mid-position of the cable's stroke.

Articulation of the ball joint should be minimal and not exceed ± 5 degrees from the center line.

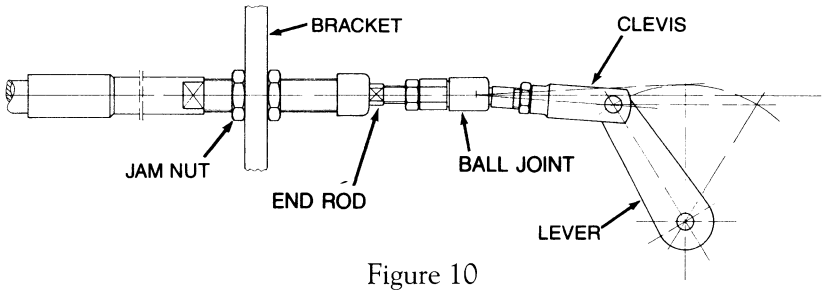


Figure 10

Swivel Tube (Figure 11):

The axis of the cable's mounting sleeve should be midway between the high point and the low point of the lever arc. This insures equal articulation of the swivel tube and uniformity of forces and stroke.

Mid-position of the lever travel should coincide with mid-position of the cable's stroke.

IMPORTANT: In installations with severe lever arc articulation, **Flexball®** must be routed so that the first bend in the cable after the end fitting follows the same plane as the lever arc. This will allow the swivel tube to articulate a total of 16 degrees (8 degrees either side of center.)

However, in applications with mild lever arc articulation (3 degrees or less either side of center) this requirement is not necessary.

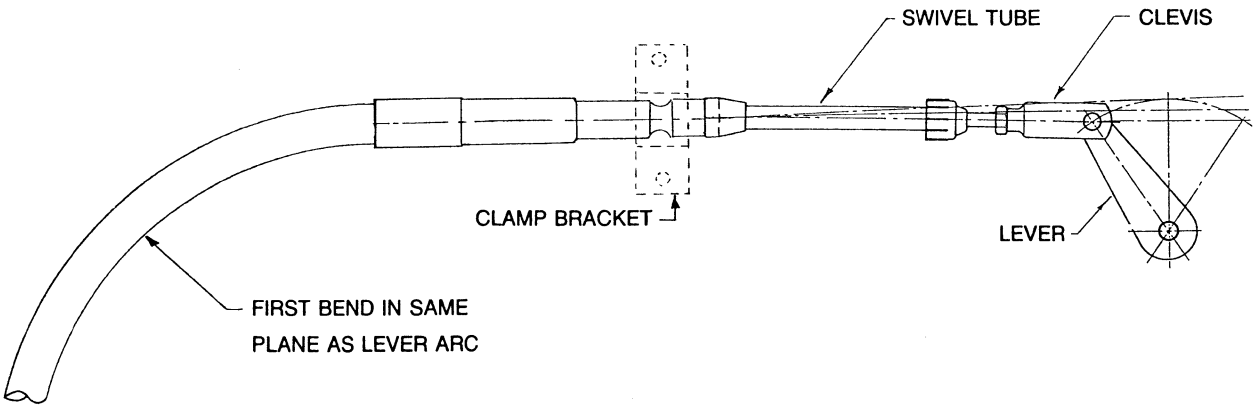


Figure 11

Points to Remember:

When connecting the ends to input control mechanisms and/or operators, be sure that these do not over-ride the designated stroke of the **Flexball®** cable. (Example: The threads on the end rod should never be pushed in beyond the rod seal located on the tip of the swivel tube.)

Never turn or twist the end rod. This can cause the center rail to corkscrew and make the cable inoperable.

Do not place any sharp bends in the cable directly after the end fitting. (Allow at least a 7-inch bend radius for Type 78, an 8-inch bend radius for Type 98, and a 12-inch bend radius for Type 128.)