35 – BRAKE-CABLE SYSTEMS

ABOUT THIS CHAPTER

This chapter is about setting up and servicing the cables that operate the brakes. It covers selection of the inner wire and housing, as well as the sizing and preparation of the housings. Attaching the inner wire to the brake lever is covered in the previous chapter. Attaching the inner wires to the brakes and adjusting the tension on the inner wire is covered in the **CABLE-OPERATED RIM BRAKES** chapter (at different locations for different types of calipers).

GENERAL INFORMATION

TERMINOLOGY

Cable: The term *cable* is used to refer to the complete cable system, including the inner wire, housings, and fittings. The term *cable* is often used to refer to the inner wire as well. To avoid confusion, this book will always use *cable* to describe the whole system, and *inner wire* to describe the wire portion of the cable system.

Housing: The outer sheath that covers portions of the inner wire. It is used to guide the inner wire around bends and to connect points that move in relation to each other.

Compressionless housing: This is housing that has stiff wires embedded in it that run along the length of the housing to reduce compression. To identify this housing, look at the cut end. Many wire ends will be seen. *This housing is used exclusively on derailleur systems!*

Housing liner: A plastic sheath inside the housing that is used to reduce friction. It is almost always fixed permanently in place.

Wound housing: This type of housing, typically used on brakes, consists of a single coil wound from one end of the housing to the other. It is usually covered in a plastic sheath and often has a liner inside. To identify it, look at the cut end. It will look like the end of a coil spring. If not sure after looking at the end, strip off the plastic sheath for a few millimeters at the end. Whether it is a single coil (wound), or multi-strand (compressionless), will become clear.

Ferrule: A cap that fits on the end of the housing to improve its fit into a housing stop.

Inner wire: The wire that is attached to the brake lever, passes through housing on the way to the brake, and attaches to the brake. At times it may just be called the *wire*.

Drawn wire: Wires that have been drawn through a die to change their shape. The process flattens the individual strands of the inner wire so that the surface of the inner wire is smoother.

Inner-wire head: The barrel-shaped or mushroom-shaped bead at the end of the inner wire. It fits in a socket in the brake lever arm.

Housing stop: A socket-like fitting on the frame, brake lever, or brake. The stop is the point where the housing ends and the inner wire continues.

Adjusting barrel: A hollow screw that changes the effective length of the brake inner wire. It is inserted into the lever body. The brake inner wire goes through the adjusting barrel. The outer end of the adjusting barrel has a socket into which the cable housing is inserted.

PREREQUISITES

Whenever cables are serviced or installed, brake adjustments must be done.

INDICATIONS

Maintenance

Cables just wear out. There may be no overt symptoms, but a cable can operate sluggishly just because it is old. Cables are vital to brake performance and relatively inexpensive. It is no extravagance to regularly replace the cable system, particularly if you are adjusting a brake.

Difficult brake operation

When the lever becomes difficult to operate, and lubing the brake lever does not solve the problem, it is likely there is a cable problem.

Rusty or damaged inner wire

Inner wires fail because they get rusty, fray, become kinked, or because the wire sheath tears on a Gore-Tex cable. Replace all wires with these problems, even when the damage does not seem to be in a critical location.

Damaged and dirty housings

Housings fail because they get kinked or bent, and because the plastic outer sheath cracks. Dirt can also get inside a housing and substantially increase friction.

Housings get kinked or bent because of impact and over-extension, but they also get damaged in the same way because they are mis-sized. Kinked and bent housings should be replaced, unless the housing is too long and the damage is confined to an area that will be cut off.

Dirt gets inside housings and increases friction. There is no good way to inspect for it and there is no good way to clean it out. It could be abrasive particles embedded in the inner liner. This hidden dirt is the likely reason that a used cable system that looks fine still does not feel as good as when new. This hidden dirt is reason enough to routinely replace cable systems when adjusting brakes.

Handlebar and stem changes

When the handlebar width, stem height, and stem length are changed, the loops of housings at the brake levers need to be re-sized. If the brake levers are moved further away because of wider bars or longer stem, it usually means cable replacement.

TOOL CHOICES

The only tools required for installation of cables are appropriate tools for cutting inner wire and housing. Preferred tools are in **bold**. Tools are preferred because of a balance among: versatility, quality, and economy.

CABLE TOOLS (table 35-1)

Tool	Fits and considerations
Park CN-2	Cuts inner wires only
SunTour TA110	Cuts inner wires only
Hozan C214	Cuts inner wires only
Hozan C215	Cuts inner wires and compressionless housing
Shimano TL-CT10	Cuts inner wires and compressionless housing
VAR 990	Cuts inner wires and compressionless housing
Felco C7 Deluxe	Cuts inner wires and compressionless housing
United Bicycle Tool MS-BURR	Removes burr from filed or ground housing end
7–8" diagonal side cutter, any brand	Cuts wound housing

ABOUT THE REST OF THIS CHAPTER

The rest of this chapter is divided into several sections. The first is ***CABLE TYPES AND COMPATIBILITY***, which covers the different types of inner wires and housings used for brake systems, and compatibility of the different types with different braking systems. The next section is ***SIZING HOUSING LOOPS***, which covers how to determine the optimum length of housing loops to either brake and to brake levers of all types. The final section is ***PREPARATION AND INSTALLATION OF THE CABLE SYSTEM***, which covers housing-end finishing, cable-system lubrication, and routing considerations.

Unlike other chapters in this book, there is no section on troubleshooting. This is because cable problems are covered in the **CABLE-OPERATED RIM BRAKES** chapter (page 36-44).

CABLE TYPES AND COMPATIBILITY

INNER WIRES

Inner wires differ by diameter, type of surface, and type of construction.

Inner-wire diameter

Wire diameter is important in regard to compatibility with the housing. Conventional housing has a 5mm outside diameter; wires of 1.5–1.8mm diameter will fit this size. Oversize brake-cable housing has a diameter of 6mm, and works with inner wires with a 2.0mm diameter.

There are no real advantages to the oversize-cable system, and manufacturers don't design cable systems this way any more. Some older bikes have brake-lever fittings and frame fittings that are designed for the 6.0mm housing. If this is the case, then it is best to use the oversize cables.

Inner-wire surface

Unlike indexing-derailleur systems, brake systems will work adequately no matter what the quality of the cable is. To optimize performance, however, a smooth cable surface is preferred to a rough surface. One way to ensure that the wire is smooth enough is to use *drawn inner wires*, which have the smoothest surface available. Most drawn inner wires will be marketed as such, but the appearance will identify them as well. Drawn inner wires have a more reflective surface, and the individual strands are much less obvious. When looking at drawn inner wire, instead of seeing individual strands, it just looks like there are

tiny grooves spiraling around the inner wire. Drawn inner wire also feels much smoother when pulled between the fingertips.

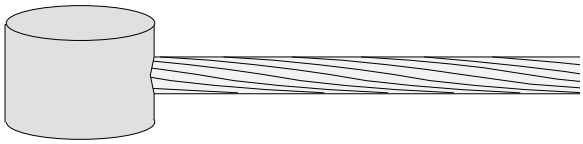
Inner-wire construction

Most inner wires today are a simple twisted wire. Several strands are laid parallel and then twisted together all at once. There is another construction, which might be called *braided*. It is not actually braided, but has that appearance. It is made by making several very small twisted-wire cables, and then twisting these together to make a larger cable. This *braided* (or *double-twisted*) inner wire is more supple than the same thickness of a simple twist. For this reason, most 2.0mm inner wires are the braided type.

INNER-WIRE HEADS

Barrel heads

The barrel-headed inner wire is used on virtually all brake levers except those found on brake levers made for drop-bars on road bikes. This type has a cylinder-shaped head that is usually slightly longer than its diameter. The wire goes into the side of the cylinder.



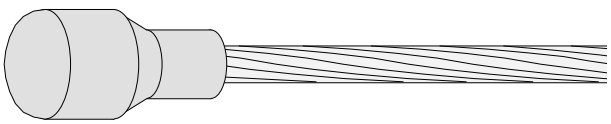
35.1 *Inner wire with barrel head.*

The most common barrel diameter is approximately 7.0mm. An 8.0mm-size barrel has been made, but wires with this size barrel are probably very difficult to find. The 7.0mm size can be used, instead.

The length of the barrel also varies. Even if the barrel protrudes from the socket or anchor, it is not a problem unless the barrel interferes with the lever body. Barrels that are too long can easily be filed shorter.

Mushroom heads

Mushroom heads are used almost exclusively on brake levers made for use on drop-bars for road bikes. The mushroom head typically has two diameters. The inner wire comes out the end of a narrower cylinder that with a 3.5–4.0mm diameter that mushrooms out to 6.0mm at the end.

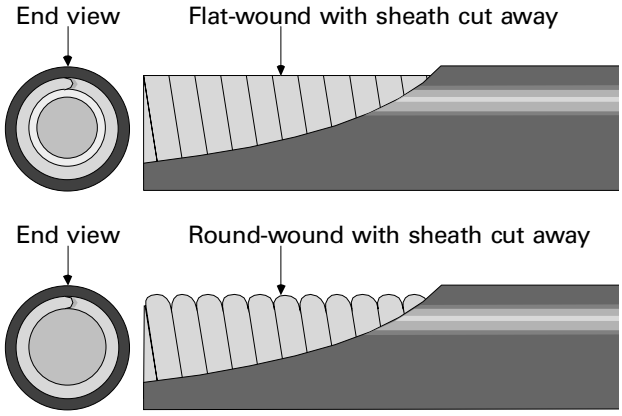


35.2 *Inner wire with mushroom head.*

HOUSINGS

Housing for brake systems must of be the wound variety. The compressionless variety is not designed to withstand the loads that are put on brake inner wires. *Catastrophic failure could result if compressionless housing were used on a brake system!*

Wound housings have a metal strip that is wound like a coil spring. Most wound housing has a plastic liner inside to reduce friction, but some cheap varieties are exposed metal inside. The ones without a liner generate more friction, and are more likely to rust solid, rendering the brake useless. Wound housing might be "flat wound" or "round wound." The flat-wound variety is more common, stiffer, and stronger; flat-wound housing is made from wire that is flat.



35.3 *Flat-wound and round-wound housing types.*

SIZING AND ROUTING HOUSING LOOPS

SIZING HOUSING TO IMPROVE BRAKE PERFORMANCE

Sizing the housing loops is critical to good brake performance for several reasons. The shorter the housing, the less friction there will be on the inner wire (to a point). When the housing is too short, then it bends more, which increases friction and increases compression under load. The additional compression creates lost brake-lever motion. Tight bends should be avoided because they cause the coils in the housing to open more. When the brake inner wire is under load, these coils compress, which causes lost lever motion and effort.

The housing loop at the brake lever must also be sized to permit a normal range of motion of the handlebar, or the housings will be damaged when the bar moves to its limit.

The goal, when sizing any housing loop, is to make it as short as possible without creating any abrupt bends, or limiting the handlebar's range of motion.

Most factories set up new bikes with brake lever housings that are much longer than is ideal. This may be because it allows use of the same cable sets on multiple bike sizes, or it may be because the factory anticipates that the shop may end up putting on a longer stem for the customer (requiring more cable length). Unfortunately, bikes routinely set up with housings too long train the customer's (and the mechanic's) eyes to accept something wrong as normal. Do not let any preconceptions about what looks normal prevent the decision to correctly size the housing loops.

MTB-BRAKE-LEVER HOUSING LOOPS

Normal routing

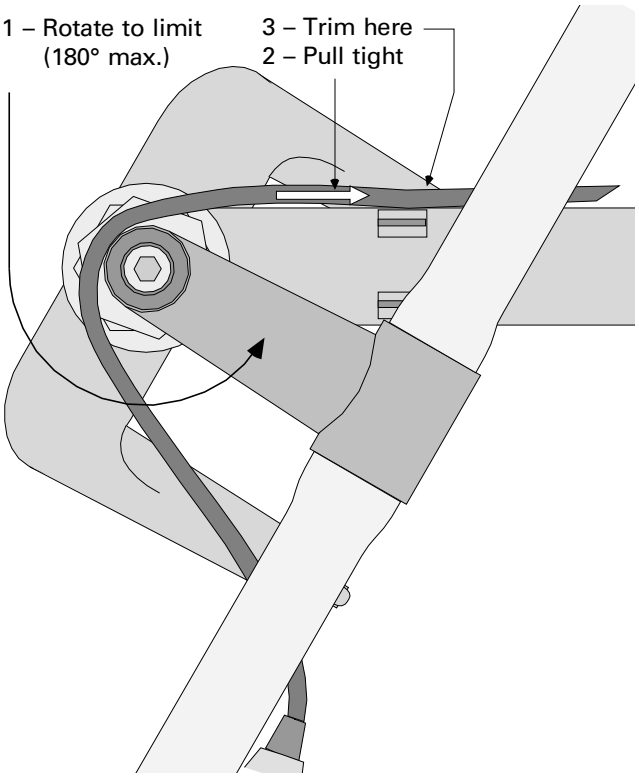
It is normal that the cable from the right lever go to the rear brake. It may be changed at customer request, but not because the shop decides that the unconventional routing is better and should be the shop standard. Anyone that has ever ridden a bike with hand brakes expects the right lever to operate the rear brake; it would be dangerous to surprise someone with a bike that had levers set up opposite from the norm.

Sizing right-lever housing loop

1. **[ ] Slide piece of housing onto inner wire coming out of brake lever.**

There may be a housing stop for the rear-brake cable at the front end of the top tube, either centered on the top or offset to the right or left side. If the housing stop is centered on the top of the tube, then the loop from the right lever may go around either side of the stem. If the bars are narrow or the stem is short, it may be preferred to go around the left side of the stem to correct the abrupt bend. If the housing stop is on the right side of the frame, then the housing loop must pass the right side of the stem. If the housing stop is on the left side of the frame, then the housing loop must pass the left side of the stem.

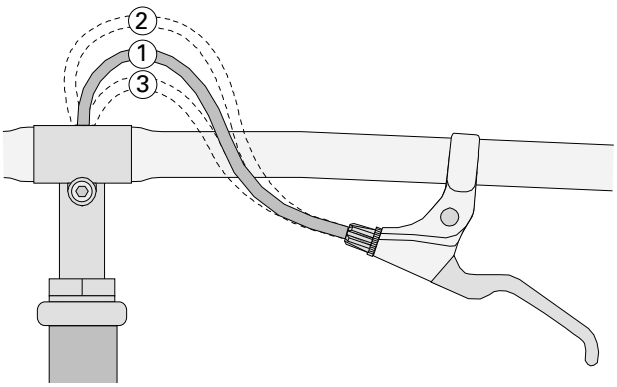
2. **[ ] Route housing to housing stop on frame that will be used, making sure that loop does not have to deflect around derailleur cables.**
3. **[ ] Rotate handlebars to limit (180° max.) to side opposite the side of the stem that the housing is routed on.**
4. **[ ] Pull housing as far as it will go past housing stop that is on frame (without damaging housing), making sure housing remains inserted in housing stop on brake lever.**
5. **[ ] Mark housing at point that is even with closed end of housing stop on frame.**
6. **[ ] Remove housing from inner wire and cut housing at mark.**



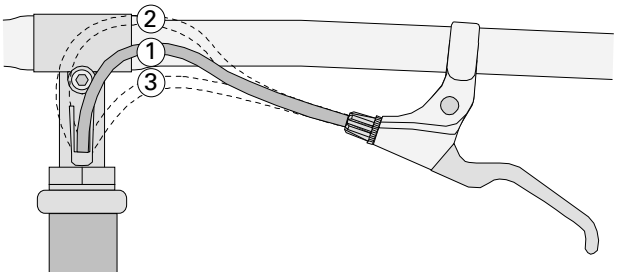
35.4 Sizing the housing loop from a right-side MTB lever.

Sizing left-lever housing loop

The loop of housing from the left lever may go to any one of locations; it may end at a stop on top of the stem, at a stop on the bottom of the stem, at a stop built into the headset, at a stop built in to a bridge that connects the two sides of the fork, or at the brake. In *every* case, the housing-loop length should be set as short as possible, without creating an abrupt bend where it enters the stop at either end. It should also be routed so that it does not have to deflect around anything.



35.5 When the housing length is correct (1), it enters the stop on the top of the stem in a straight line. When the housing length is too long (2) or too short (3), the housing enters the stop on top of the stem at an angle.



35.6 When the housing length is correct (1), it enters the stop on below the stem in a straight line. When the housing length is too long (2) or too short (3), the housing enters the stop below the stem at an angle.

If one end of the housing ends at a stop on a caliper arm, then the motion of the caliper arm should be considered. When sizing the housing, the caliper arm should be in a position close to its actual working position.

1. **[ ] Slide piece of housing onto inner wire coming out of brake lever.**
2. **[ ] Find route for housing from lever to other stop (at stem, headset, bridge, or caliper) that is as direct as possible without any unnecessary deflections or avoidable abrupt bends.**
3. **[ ] If housing will be routed to stop on a caliper arm, use brake fourth-hand tool to hold pads to rim to put caliper in its working position.**
4. **[ ] With housing positioned adjacent to stop that is closer to brake, adjust housing longer and shorter until length is found that keeps abrupt bends to a minimum, where housing enters stops.**
5. **[ ] Mark housing at point that is even with closed end of housing stop.**
6. **[ ] Remove housing from inner wire and cut housing at mark.**

DROP-BAR/AERO'-BRAKE-LEVER HOUSING LOOPS

Aero' brake levers that are designed to have the brake-cable housing routed along the handlebar (underneath the handlebar covering). Non-aero' levers have free loops of housing that rise several inches above the brake lever and handlebar. The housing leaves the aero' lever at its base and remains adjacent to the handlebar until it reaches the end of the handlebar covering, a few inches from the point the handlebar goes into the stem.

Normal routing

It is normal that the cable from the right lever go to the rear brake. It may be changed at customer request, but not because the shop decides that the unconventional routing is better and should be the shop standard. Anyone that has ever ridden a bike with hand brakes expects the right lever to operate the rear brake; it would be dangerous to surprise someone with a bike that had levers set up opposite from the norm.

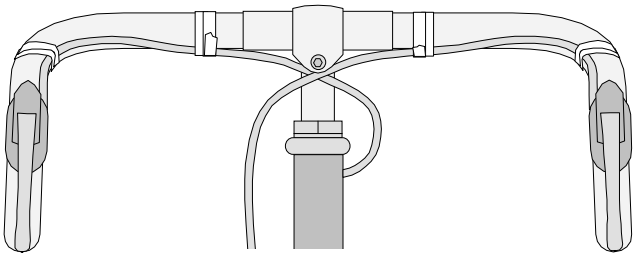
Sizing right-lever housing loop

1. **[ ] Slide piece of housing into socket on base of lever body.**
2. **[ ] Route housing so that it comes out of the base of the lever body and gradually transitions to underside of handlebar, unless a groove is provided in face of handlebar to seat housing in.**
3. **[ ] Retain housing temporarily with adhesive tape or ties to handlebar, only to point handlebar covering will end near stem.**

There may be a housing stop for the rear-brake cable at the front end of the top tube either centered on the top, or offset to the right side. If the housing stop (or guide) is centered on the top of the tube, then the loop from the right lever may go around either side of the stem; usually, it is preferred to go around the left side of the stem to reduce the abruptness of the bend. However, if the housing stop is on the right side of the frame, then the housing loop must pass the right side of the stem. If the housing stop is on the left side of the frame, then the housing loop must pass the left side of the stem.

4. **[ ] Route housing to housing stop on frame that will be used.**
5. **[ ] Rotate handlebars to limit (90° max.) to side opposite side of stem that housing is routed on.**

6. [ ] **Pull housing as far as it will go past housing stop on frame (without damaging housing), making sure housing remains inserted in housing stop on brake lever and does not pull out of tape or tie on handlebar.**
7. [ ] **Mark housing at point that is even with closed end of housing stop on frame.**
8. [ ] **Remove housing from inner wire and cut housing at mark.**



35.7 Cable routing from aero' brake levers.

Sizing left-lever housing loop

The loop of housing from the left lever may go to any number of locations. It may end at a stop on the bottom of the stem, at a stop built into the headset, at a stop built in to a bridge that connects the two sides of the fork, or at the brake. In *every* case, the housing-loop length should be set as short as possible, without creating an abrupt bend where it enters the stop or departs from the handlebar. It should also be routed so that it does not have to deflect around anything.

If one end of the housing ends at a stop on a caliper arm, then the motion of the caliper arm should be considered. When sizing the housing, the caliper arm should be in a position close to its actual working position.

1. [ ] **Slide piece of housing into socket on base of lever body.**
2 [ ] **Route housing so that it comes out of the base of the lever body and gradually transitions to underside of handlebar, unless a groove is provided in face of handlebar to seat housing in.**
3. [ ] **Retain housing temporarily with adhesive tape or ties to handlebar (only to point handlebar covering will end near stem).**
4. [ ] **Find route for housing from handlebar to other stop (at stem, headset, bridge, or caliper) that is as direct as possible, without any unnecessary deflections or abrupt bends.**
5. [ ] **If housing will be routed to stop on a caliper arm, use brake fourth-hand tool to hold pads to rim to put caliper in its working position.**
6. [ ] **With housing positioned adjacent to stop, adjust housing longer and shorter until length is found that keeps abrupt bends to a minimum (where housing enters stops).**
7. [ ] **Mark housing at point that is even with closed end of housing stop.**
8. [ ] **Remove housing from inner wire and cut housing at mark.**

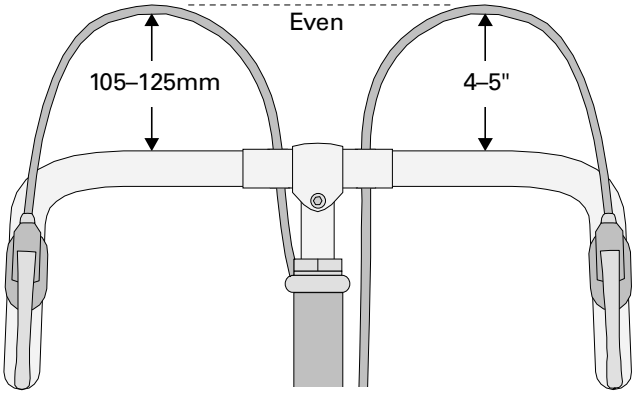
DROP-BAR/NON-AERO'-BRAKE-LEVER HOUSING LOOPS

Non-aero' brake levers are brake levers that are designed to have the brake-cable housings rise out of the top of the lever bodies and form free loops that go over the top of the handlebar on the way to the brakes.

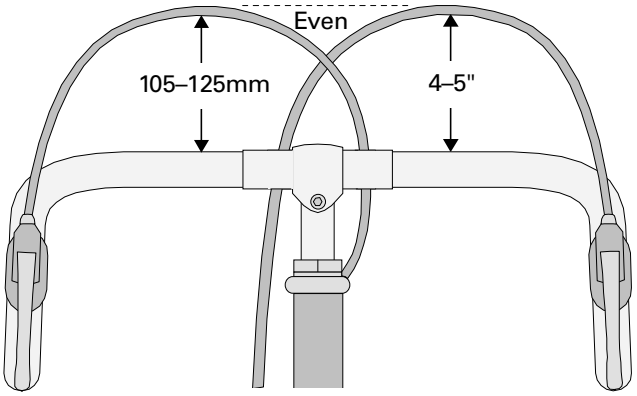
Normal routing

It is normal that the cable from the right lever go to the rear brake. It may be changed at customer request, but not because the shop decides that the unconventional routing is better and should be the shop standard. Anyone that has ever ridden a bike with hand brakes expects the right lever to operate the rear brake; it would be dangerous to surprise someone with a bike that had levers set up opposite from the norm.

The housing loops should be of equal height, and should peak at a height of 115mm (±10mm) above the handlebar. This is equal to a height of 4.5" (±.5").



35.8 Normal cable routing when the housing stop on the front brake is on the bike's left side.



35.9 Normal cable routing when the housing stop on the front brake is on the bike's right side.

Sizing right-lever housing loop

1. [ ] **Insert ferrule into hole in top of lever body.**
2. [ ] **Insert one end of housing piece into ferrule.**

There may be a housing stop (or housing guide) for the rear-brake cable at the front end of the top tube either centered on the top, or offset to the right or left side. If the housing stop (or guide) is centered on the top of the tube, then the loop from the right lever may go around either side of the stem. If the front brake has a housing stop on the right side of the bike , it may be preferred to go around the left side of the stem to make the front and rear loops appear more symmetrical. If the housing stop is on the right side of the frame, then the housing loop must go by the right side of the stem. If the housing stop is on the left side of the frame, then the housing loop must go by the left side of the stem.

Some bikes are set up with the housing loops from the brake levers routed *under* the handlebar. This decreases support for the housing, leading to an increase in housing failure; routing over the top of the handlebar is strongly recommended.

3. [ ] **Route housing over handlebar, past correct side of stem, and to housing-stop/guide on frame.**
4. [ ] **Adjust length of loop so that it peaks 115mm (±10mm) above top of handlebar. (Make loop height equal to left-side loop, if left-side loop is in acceptable height range.)**
5. [ ] **If housing will stop at fitting on top tube, mark housing at point that is even with closed end of housing stop on frame, then cut housing at mark.**
6. [ ] **If housing will go through a tunnel guide and will not stop until it is past the seat tube, use tape to temporarily fix housing to top tube when loop height is correct. (Excess housing length will be removed when sizing loop at rear brake.)**

Sizing left-lever housing loop

The loop of housing from the left lever may go to a variety of locations. It may end at a stop built into the headset, at a stop built in to a bridge that connects the two sides of the fork, or at the brake. The stop at the brake may be on the left, the right, or even at the center. In *every* case, the housing-loop length should be set at a length that makes it equal in height to the right-lever loop (unless the right-lever loop is outside the acceptable range). It should also be routed so that it does not have to deflect around anything.

If one end of the housing ends at a stop on a caliper arm, then the motion of the caliper arm should be considered. When sizing the housing, the caliper arm should be in a position close to its actual working position.

1. [ ] **Insert ferrule into hole in top of lever body.**
2. [ ] **Insert one end of housing piece into ferrule.**
3. [ ] **If housing stop is on brake caliper, use brake fourth-hand tool to hold pads to rim so that housing stop will be in its working position.**

If the housing stop for the front brake is in any of the following locations: on the left side of the brake caliper, on the headset, on the center of a bridge between the sides of the fork, or on the brake at the center, then the left-lever housing loop should come down on the left side of the stem. If the housing stop is on the right side of the brake, then the housing loop should come down on the right side of the stem.

Some bikes are set up with the housing loops from the brake levers routed *under* the handlebar. This increases housing bends, leading to an increase in housing failure; routing over the top of the handlebar is strongly recommended.

4. [ ] **Route housing over handlebar, past correct side of stem, and to housing stop.**
5. [ ] **Adjust length of loop so that it peaks 115mm (±10mm) above top of handlebar. (Make loop height equal to right-side loop, if right-side loop is in acceptable height range.)**
6. [ ] **Mark housing at point even with closed end of housing stop, then cut housing at mark.**

BMX/FREESTYLE-BRAKE-LEVER HOUSING LOOPS

Sizing and routing the right-brake-lever housing loop

The housing loop from the right brake lever goes to the top tube in most cases, but on occasion goes to a device on the stem called a rotor.

If the housing loop goes to the top tube, it should be set just long enough to allow full rotation of the handlebar, or 360° of rotation (whichever comes first). The housing should go below the handlebar and stay to the right side of the stem.

If the housing is routed to a rotor, it should be a gentle curve that is as short as possible, without creating any abrupt bends at either end.

Sizing and routing the left-brake-lever housing loop

The housing loop from the left brake lever usually goes directly to the brake, but is sometimes routed down through the center of the stem.

If the loop of housing goes directly to the brake, the brake pads must be held to the rim while sizing the housing loop. The loop should be a gentle curve that is as short as possible, without creating any abrupt bends at either end. The housing should stay in front of the handlebar.

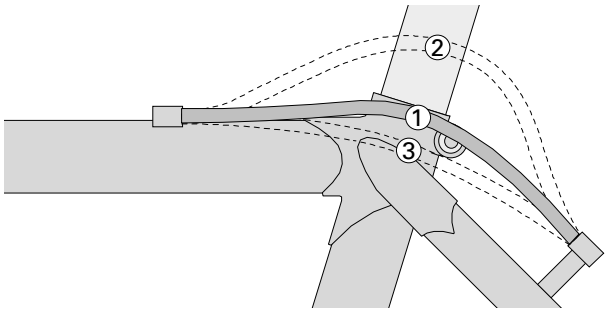
If the housing is routed into the center of the stem, the loop should be a gentle curve that is as short as possible, without creating any abrupt bends at either end. The housing should stay in front of the handlebar.

UPRIGHT-BAR BRAKE-LEVER HOUSING LOOPS

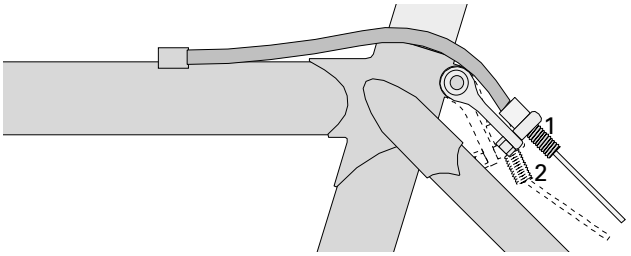
The housing loop from the right lever should be set up in the same fashion as on an MTB right lever. The housing loop for the left lever should be set up in the same fashion as a BMX/freestyle left lever that has housing routed directly to the brake.

REAR-HOUSING-STOP LOOPS

The loop can go around either side of the seat post/seat tube, except that it should be on the opposite side of any seat post quick-release lever. The length of the loop should be set to minimize abrupt bends where the housing enters the stops, and to minimize double bends. If the housing stop is a hanger mounted to the seat-post binder, the angle of the hanger might need to be adjusted. The hanger position should be set so that the inner wire will come out of the hanger parallel to the line of the hanger or any adjusting barrel on the hanger.



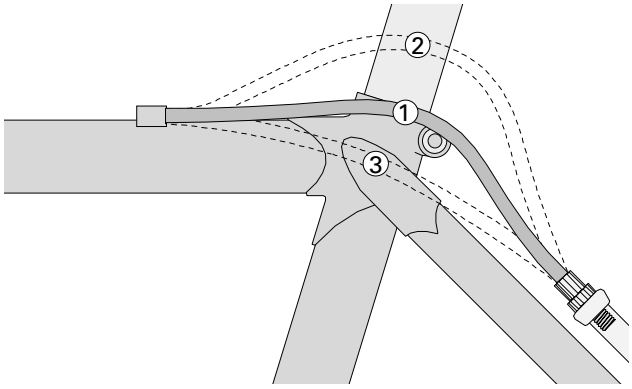
35.10 *When housing is the correct length (1), it enters the stop straight. When it is too long (2) or too short (3), then it bends at the point it enters the stop..*



35.11 *When an adjustable cable hanger is correctly aligned (position 1), then the inner wire leaves the adjusting barrel without a bend. If the hanger is incorrectly aligned (position 2), the inner wire changes direction as soon as it exits the adjusting barrel.*

REAR-CALIPER HOUSING LOOPS

The position of the housing stop on a caliper changes as the caliper opens and closes. The small amount of motion that occurs under normal operation of the caliper is not an issue; however, when the caliper is not hooked up, the housing stop will move a significant distance from its operating position. For this reason, the brake pads should always be held to the rim when sizing a loop of housing that goes to the caliper. The length of the loop should be set to minimize abrupt bends where the housing enters the stops, and to minimize double bends.



35.12 *When the length of the housing loop to a rear sidepull brake is correct (1), then it enters the adjusting barrel in a straight line. If the length is too long (2), or too short (3), then the housing bends as it enters the adjusting barrel.*

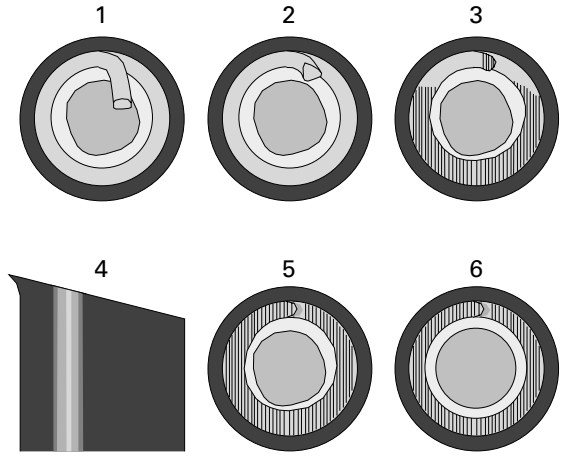
PREPARATION AND INSTALLATION OF THE CABLE SYSTEM

HOUSING-END FINISH

After cutting a piece of wound housing to length, the end must be properly finished to optimize brake performance. The fresh-finished surface should cover all 360° of the end of the housing, and the surface should be perpendicular to the axis of the housing. A hand file or grinder can be used to clean up the end of the housing. After the end has been filed or ground, then a taper reamer is used to remove any internal burr that may have been created during the filing or grinding.

When using a grinder to finish the end of the housing, a great deal of care must be used to prevent heat from building up and melting the outer plastic sheath or inner liner. Press the end of the housing very lightly against the grinding wheel to reduce heat. A useful technique to keep the housing cool is to dip the end into a water bath after every 2–3 seconds of grinding. The housing should be supported on the grinder's tool rest to keep the housing aligned to the wheel surface, and to prevent the end of the housing from being pulled out of line by the grinding wheel.

A file is slower to use, but less likely to create enough heat to melt the plastic on the housing. Care must be taken to keep the end of the housing perpendicular to the file face to prevent the finished face of the housing from ending up at the wrong angle.



35.13 *1. Mangled coil: needs to be re-cut. 2. Good cut: ready for finishing. 3. Incompletely filed or ground end. 4. Filed end not perpendicular to housing axis. 5. Completely finished end ready for reaming. 6. Filed and reamed housing end.*

After filing or grinding a piece of housing, the inner liner may need to be reopened, and burrs left by the filing or grinding need to be removed. A pushpin is a useful devise for reopening the inner liner. A miniature taper reamer (of the type used with a rotary/Dremmel tool) is useful for removing the burr from the inside of the housing end.

INSTALLING FERRULES

It is important to use ferrules *anytime they will fit*. Fit a ferrule onto the housing and check if the ferrule will install into the housing stop or adjusting barrel. If it fits without jamming, it must be used. Dia-Compe aero' brake levers use a special ferrule that has a larger O.D. than common ferrules.

Crimping ferrules onto housing

Ferrules come from the factory crimped onto the housing so that they won't get lost in transit. Once a cable is installed on a bike, there is no advantage to having the ferrules crimped on. Crimping is a waste of time, and it complicates re-using them. Crimping ferrules is not recommended.

LUBRICATION

Any housing used for brake systems should be lined with a plastic sheath. Performance will always be improved by dripping or spraying oil into the housing before installing the cable system. Grease should not be used because it can congeal when it gets cold or old, which lowers the performance of the cable system.

Unlined housing is not recommended, but if used, the best lubricant is grease, which should be put on the inner wire.