Installing a T5 5-speed Transmission in a C2 Corvette

(Photo by CF member Tom Austin)

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INTRODUCTION

Some owners of C2 Corvettes would love to install a 5-speed manual transmission in their C2, but they are put off by the high cost of a Tremec TKO-600 5-speed conversion kit (about $4000). Several years ago, I installed a TKO-600 in my '67 Corvette, and I love it. It's the best single modification I have ever made to my '67.

If you don't mind spending the money for a TKO-600 conversion, you can probably stop reading this now, because I still think the TKO-600 is the best overall solution for putting a 5-speed in a C2. However, I have recently learned that there is a less expensive option based on using a Tremec T5 5-speed, and I think this option may be of interest to others.

I had always believed that it was "impossible" to install a T5 in a C2 because the built-in shifter in the T5 is in the wrong place. The T5 shifter is centered on the mainshaft, while the C2 shifter is offset toward the driver about 2.8". As a result, the T5 shifter does not align with the shifter opening in the cast metal console cover of a C2.

The TKO-600 has the same problem, but aftermarket vendors such as Silver Sport Transmissions sell a TKO-600 with the shifter moved to the correct location for a C2 Corvette. To my knowledge, no one sells a similarly modified T5.

In a recent discussion on Corvette Forum, I was surprised to learn that a few owners have managed to install a T5 in their C2, using some clever techniques to get the T5 shifter to come out in the right place for the C2 console. And, several C3 owners have installed T5 transmissions, using alternate techniques that take advantage of the fact that there is a bit more room in the C3 tunnel compared to the C2. Since a suitable used T5 can be acquired for $500, some owners have managed to complete the entire swap for less than $1000. This really got my attention.

In reading the Corvette Forum archives on T5 conversions (both C2 and C3), I found that there are lots of great ideas and proven solutions for installing a T5 in in a C2, but the solutions differ widely in their approach. Unfortunately, these ideas, solutions, and key photos are spread out in about ten different threads and hundreds of posts going back to 2004. An additional problem is that despite the large number of posts on T5 conversions, certain questions that came to mind as I read through them left me with some unanswered questions

For people who are interested in a possible T5 conversion, I decided to try to collect, in one place, all the information that I thought would be most useful. Most of this information was collected from T5 postings on Corvette Forum, and general T5 information available on other web sites. And, some of the information presented here was compiled by me, based on inspection and measurements of some key T5 parts.

My hope is that this document will be a useful starting point for anyone who would like to install a 5-speed transmission in their C2. The content here is focused primarily on a T5 5-speed conversion, but I have included a comparison to the TKO-600 5-speed conversion.

I expect that this document will be a "work in progress" that is updated periodically as additional information becomes available.

DISCLAIMER AND ACKNOWLEDGEMENT

I want to emphasize that I have never personally installed a T5 in a C2 Corvette. My only direct experience relevant to this topic is that several years ago I installed a TKO-600 in my C2. So, I have first-hand experience with the numerous fitment issues that have to be addressed. This made it easy for me to read and understand the

various Corvette Forum postings where people described how they overcame various problems associated with installing a T5 transmission in a C2 or C3.

My main goal for this paper is simply to gather, organize, and document the wide range of creative solutions that have been described by others in their postings on Corvette Forum.

It appears to me that certain combinations of these ideas would work well together, and I have enjoyed trying to figure which combinations might provide the best overall solutions.

The list of CF members whose posts I found useful includes, but is not limited to, Tom Austin, Silverslashstreak, Norval Wilhelm, John65, OCS1667, xoft, Frankenvette, ddecart, and DB66.

I also want to sincerely thank Stan at Pro-Force Performance (http://pro-forceperformance.com). The T5 technical information posted on Stan's web site is excellent. Stan has been rebuilding T5 transmissions since 2008, and has an encyclopedic knowledge of the various versions of the T5 and what parts can be interchanged. When I had follow up questions after reading everything on Stan's web site, Stan patiently answered numerous questions I had regarding various details.

Some portions of the following summary are new information based on my own analysis and testing, but most of what follows is simply a summary of what has been previously described by others.

My own contributions are primarily focused on possible methods for getting the T5 shifter to come out in the stock C2 location with ***no cutting of the C2 transmission tunnel.*** I find this to be a particularly interesting aspect of the possibility of installing a T5 5-speed in a C2 Corvette. My conclusion is that accomplishing this goal is very challenging, but perhaps not impossible. My investigation of this issue is still ongoing.

BENEFITS OF A 5-SPEED CONVERSION

Many people assume that the only benefit of a 5-speed transmission (with an overdrive 5th gear) is the reduced rpm at highway cruising speeds. This reduces engine noise and exhaust noise for more comfortable highway cruising on long trips. However, this is only half the benefit of installing a 5-speed.

The other big benefit is having a lower first gear for improved launch from a standing start. We have all heard that for fast acceleration, the preferred combination for a C2 was a close ratio Muncie and a 4.11 rear. This was great for acceleration in first gear, but the engine rpm at highway speeds was high and became unpleasant on long trips.

For highway cruising, the preferred rear end ratio would be something like a 3.08, but this reduces standing-start acceleration in first gear. I know one C2 owner who owns two differential assemblies, a 4.11 for street use and a 3.08 for long trips. He actually swaps the rear end from 4.11 to 3.08 every time he makes a long trip, and then changes it back to the 4.11 for local street driving.

Now, suppose you could achieve the same effect as changing from a 4.11 rear to a 3.08 rear, but accomplish this by simply shifting into a an additional 5th gear? This is what a properly set up 5-speed does for you. This is much better than physically changing the rear end, and it's better than having to compromise on a single rear end ratio such as 3.55 that you use 100% of the time with your close-ratio Muncie.

It's easy to illustrate this with an example. The "effective gear ratio" for the overall drive line is simply the transmission gear ratio multiplied by the rear end ratio. So, a close ratio Muncie (2.20 first gear and 1.00 fourth gear) has an effective first gear ratio with a 4.11 rear of (2.20 x 4.11) = 9.04. With a 3.08 rear, the effective fourth gear ratio is (1.00 x 3.08) 3.08.

Now, let's consider a representative T5 5-speed with a 2.95 first gear and a 0.68 fifth gear. If we combine this T5 with a 3.70 rear, the effective first gear is (2.95 x 3.70) = 10.9, while the effective fifth gear is (0.68 x 3.70) = 2.52.

Compared to the close ratio Muncie, the T5 5-speed and a 3.70 rear yield better standing-start launch than the Muncie with a 4.11 rear, and lower highway rpm than the Muncie with a 3.08 rear. It's the best of both worlds.

CRITERIA FOR THE "IDEAL" 5-SPEED CONVERSION

Following are what I consider to be the characteristics of an "ideal" 5-speed conversion for a C2:

- 100% bolt-in solution that is completely reversible to the stock configuration (no modifications to the transmission tunnel or the welded-in transmission crossmember).
- Can be installed without removing the engine
- Mechanical speedometer drive connects to stock C2 speedometer
- Adequate durability for use behind stock C2 engines
- Minimal need for fabrication of associated components
- Low cost

EVALUATING THE TKO-600 AGAINST THE IDEAL CRITERIA

It is important to understand that the TKO-600 conversion meets all the above criteria except for the "low cost" criterion. In particular, a TKO-600 C2 conversion kit comes pre-engineered with ALL of the required parts, such as the shifter, transmission mount, speedometer cable, transmission yoke and driveshaft. No parts have to be fabricated to complete the installation.

Figure 1 and Figure 2 show the TKO-600 kit currently offered by Silver Sport Transmissions. Fig. 1 shows all the parts that come with the C2 conversion kit, and Fig. 2 shows the resulting shifter position in a C2. Note that the shifter comes out within the stock shifter opening, so that no enlargement of the opening is required.

As we will see, the most common T5 installations require some degree of cutting to enlarge the shifter opening in the tunnel, although this cutting is completely hidden by the stock C2 console cover. Later in this document we will discuss some possible ways to eliminate the need for any cutting of the tunnel at all. This may be of interest to C2 owners who do not want to make any permanent modifications to the transmission tunnel.

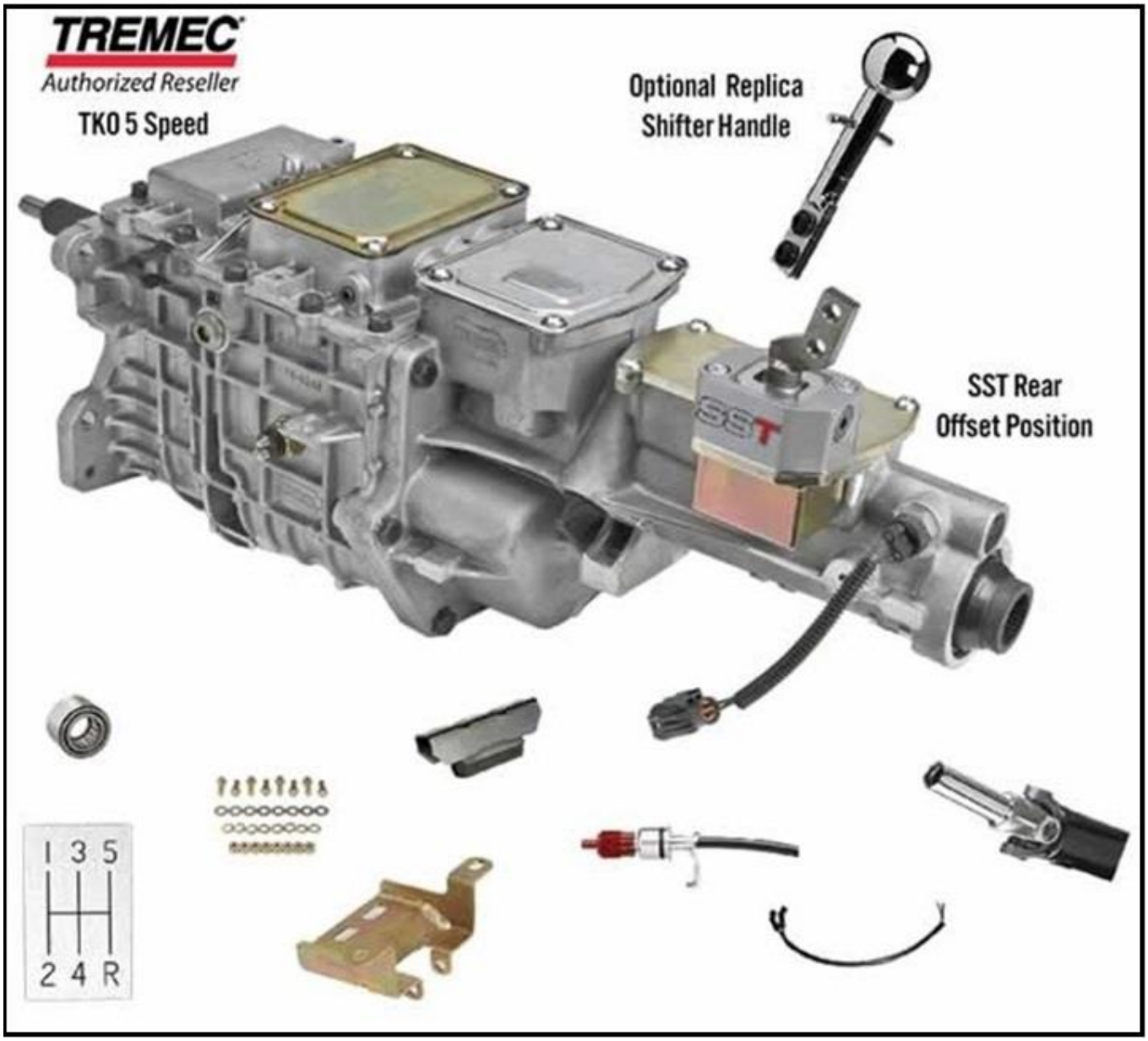

Fig. 1: Silver Sport Transmissions TKO-600 kit for a C2 Corvette

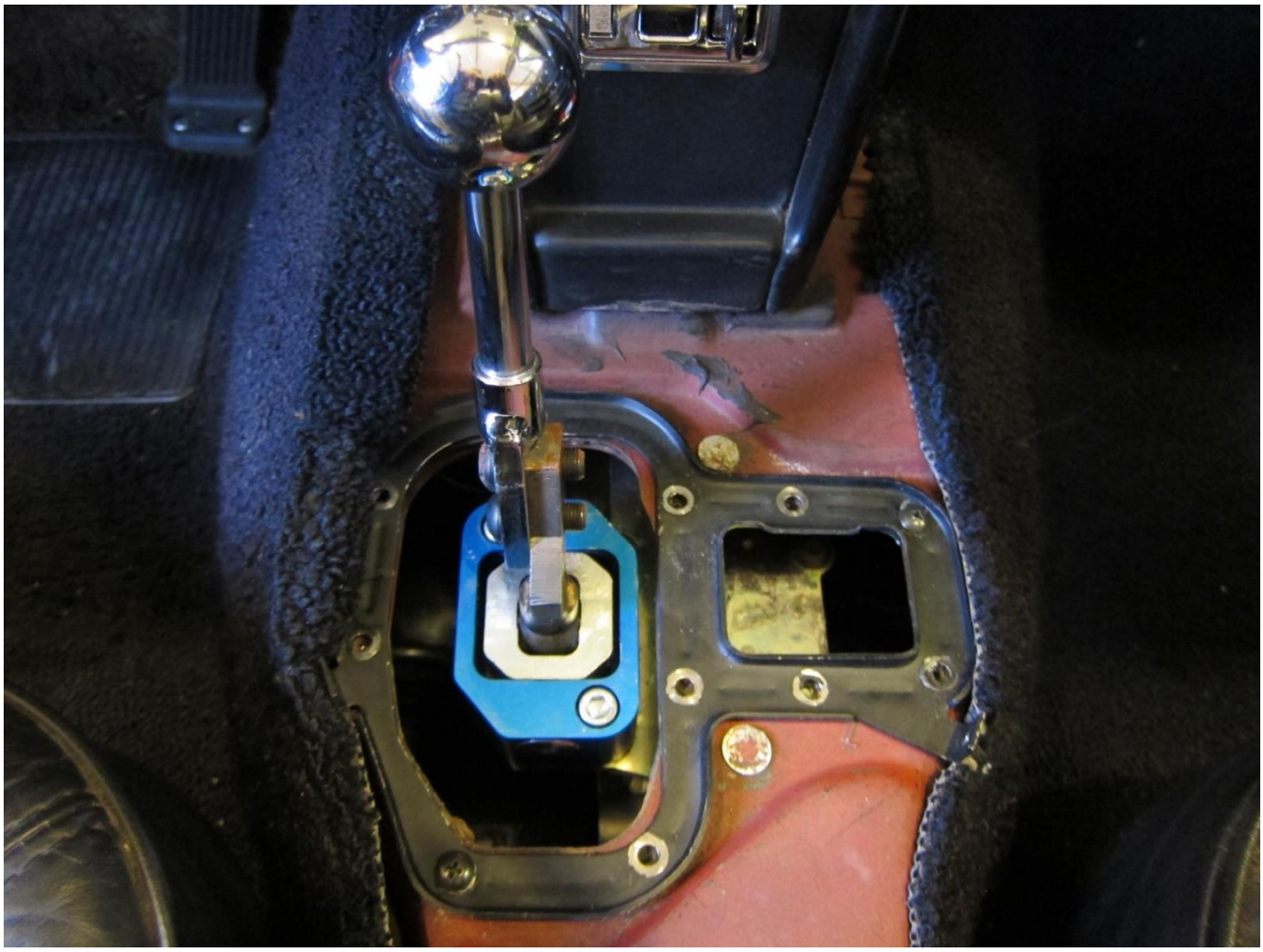

Fig. 2: Shifter position using the TKO-600 kit for a C2 Corvette

EVALUATING THE T5 AGAINST THE IDEAL CRITERIA

For the T5 conversion options discussed here, I should explain at the outset that so far, I have not seen a 100% bolt-in T5 solution for a C2. However, some proven options require only a small enlargement in the shifter opening in the tunnel, in the area covered by the C2 shifter console. So, when the installation is complete, this small modification to the tunnel is not detectable from inside the car or from under the car. I'm currently exploring a couple options for eliminating any cutting of the tunnel at all.

Another criterion for which the T5 conversion requires some explanation is "adequate durability" for use behind a stock C2 engine. The T5 has been in continuous production for over 30 years, and during that time improvements have been made to increase its durability and strength. The strongest T5 versions were developed around 1990 for use in the V8 Camaros and Mustangs.

While a range of opinions can be found on the web, the general consensus from experienced builders and users is that the V8 T5 transmissions are fine for up to 400 horsepower, provided that the driver does not abuse the transmission.

The principal form of abuse that should be avoided is what is called “power shifting.” Power shifting is a technique developed for drag racing to make up-shifts as rapidly as possible. When power shifting, the driver does two things to complete an up-shift:

1) Keep the throttle floored throughout the entire shift (never let up on the throttle)
2) “Sidestep” your foot on the clutch so that it is released only long enough to force the shifter into the next gear

Not surprisingly, this is very hard on the transmission gears and synchronizers. Experience has shown that the T5 does not tolerate power shifting as well as a Muncie. However, experience has also shown that for drivers who shift “normally,” the T5 holds up very well behind engines with up to 400 HP. Following is what would be considered a “normal” shift during a full-throttle run through the gears:

1) Lift off the throttle
2) Disengage the clutch
3) Shift to the next gear
4) Engage the clutch and re-apply full throttle

Note that ***it does not matter how fast you do these four steps***. The only problem is skipping either of the first two steps. If your car has enough power to chirp the tires on every upshift, the T5 won’t mind, as long as you shift normally. The V8 versions of the T5 have been shown to hold up extremely well as long as the above steps are followed for upshifting.

Several people have reported successfully using the T5 behind big blocks that generate more than 400 HP, but above 400 HP, opinions on the suitability of the stock V8 T5 begin to diverge.

There are aftermarket suppliers that make upgraded guts for the T5 that they claim will increase its capability into the 600 HP range. However, these upgrades can be expensive, and the extra funds required might be better applied to installing a TKO-600.

Regarding the need to fabricate certain components, some amount of fabrication will be required for any of the various options for installing a T5 in a C2 Corvette. However, most of these parts can be fabricated by persons with ordinary skills and tools. Example parts include the rear transmission mount, some shifter modifications, and other fairly straightforward items. These fabrication steps will be described in the upcoming sections.

With these caveats about “100% bolt-in,” “adequate durability,” and “minimal need for fabrication of components,” the T5 otherwise meets the listed criteria for an “ideal” 5-speed conversion. Compared to a TKO-600 conversion kit, the only criterion where the T5 clearly beats the TKO-600 is cost. Since a basic T5 installation can be completed for under $1000, it can be attractive to people who enjoy applying their creative skills to come up with a low cost conversion.

One other difference between the TKO-600 and the T5 deserves mention. Compared to a Muncie, the TKO-600 shifter is a bit “notchy.” By all accounts, the T5 is one of the smoothest-shifting 5-speeds ever made.

When shifting, the TKO-600 gates are very well defined and have a distinct feel. I personally like this, but some people prefer the butter-smooth shifting of a well performing Muncie. Another problem with the TKO-600 is that it is that it is possible to miss the 2-3 shift unless you adjust your shifting style to be slightly different from the way you shift a Muncie.

With a Muncie, you simply push up and right for the 2-3 shift, but with a TKO-600, pushing to the right can get you stuck between the third gear gate and the fifth gear gate, so that you end up with neither gear and a missed shift. The solution for the TKO-600 is to simply push the shifter forward with the palm of your hand for the 2-3 shift,

and let the pre-load springs in the shifter guide it into the third gear gate. I have found that this method works very well with the TKO-600, so it doesn't bother me. It did require some practice, though.

While I have no complaints about the way the TKO-600 shifts, some people don't like it. However, everyone seems to agree that the T5 shifting is excellent. So, for some people, this might be another aspect where the T5 beats the TKO-600.

SOME BASIC INFORMATION ABOUT THE T5 5-SPEED

The T5 transmission is sort of the "Chevy small block" of the transmission world. It has been in continuous production for over 30 years, and many of its parts, such as main cases, tail housings, and gear sets are interchangeable (with some exceptions). Certain parts are better suited to a C2 conversion than others, so it is important to be familiar with the differences and choose a version of the T5 that has most or all of the features you want.

When buying a used T5, is not necessary to get all of the desired features in the specific version you buy, because it is a simple matter to change certain parts such as the tail shaft housing or the input shaft to better suit your application.

The T5 was originally developed in about 1982 by Borg Warner, an independent manufacturer of automotive transmissions. Borg Warner made many different versions of the T5 for more than ten different car manufacturers including GM and Ford. Generally, the internal design of the T5 was similar across all manufacturers, but things such as the bolt pattern for attaching to the bellhousing, the shifter location, the rear mount location, the speedometer output location, the type of speedometer output (mechanical or electronic), and internal gear ratios were all customized for a given auto manufacturer.

In 1997, Borg Warner was purchased by Tremec, but the T5 design that Tremec makes today is essentially the same as it was when Tremec acquired Borg Warner. So, you will see people refer to the T5 as either a Borg Warner transmission or a Tremec transmission, but it is basically the same transmission.

Below is a photo of a brand new T5 that you can buy today for about $2000 from Summit Racing. This version is offered through Ford Racing as part number M-7003-Z, so it has a Ford bolt pattern, a Ford input shaft, and a Ford output shaft. As we will see, though, those details are not necessarily a problem for a C2 conversion. The main attributes of the M-7003-Z are that it is a brand new transmission (as opposed to a used one), and it contains all of the strength and durability improvements that were developed over the years that the T5 was being used in Camaros and Mustangs.

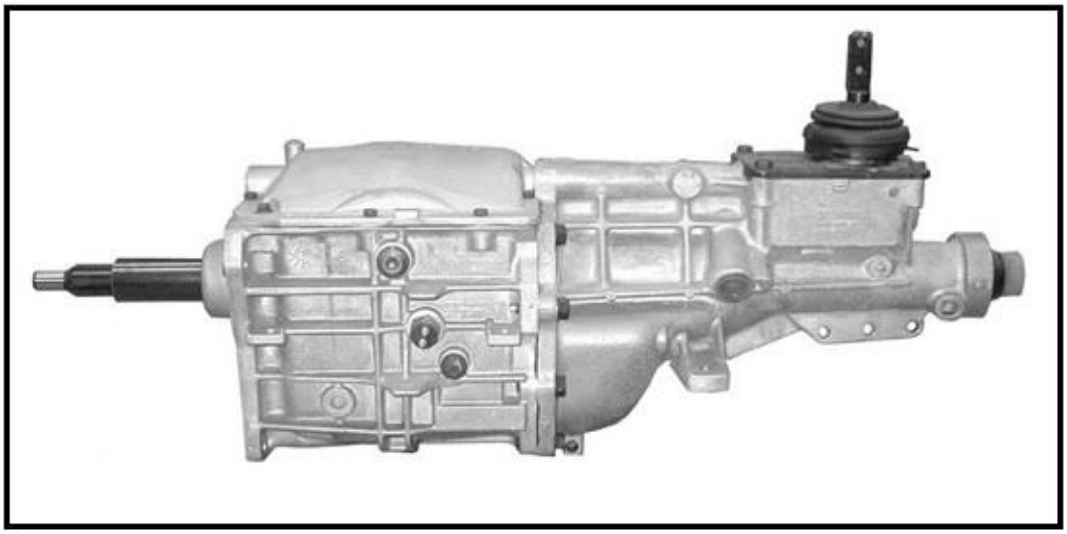

Fig. 3: Ford Racing T5, part number M-7003-Z

In the photo above, note that shifter is centered directly over the mainshaft. This is the key problem with putting a T5 into a C2 Corvette. The C2 Corvette was designed for a Muncie 4-speed, where the shifter was external to the transmission and was bolted to the driver side of the tail housing. The Muncie shifter location is about 2.8 inches closer to the driver than the T5 shifter location. In the Ford/Mustang T5 version shown above, the shifter is approximately the same distance back from the bellhousing as the Muncie location. Camaro versions of the T5 have the shifter located about 1.8 inches farther back than the Mustang version.

GETTING THE T5 SHIFTER TO COME OUT IN THE C2 LOCATION

Since no one makes a T5 conversion kit for the C2 Corvette, some creative C2 owners have developed various methods for getting the T5 shifter to come out in the right place for a C2 Corvette. It turns out that there are several proven methods for installing a T5 in a C2 Corvette, and each have various pros and cons. Following are the two basic approaches that have been used:

Option 1: Tilt the transmission toward the driver

This method was used by GM in the 1983-1992 Camaro and Firebird when GM switched from the Muncie 4-speed to the T5 5-speed starting in 1983. A special bellhousing was designed that tilts the transmission about 19 degrees toward the driver. The result of this tilting was that the shifter moved to the correct location to closely match the location of the previous Muncie shifter.

Note that for 1983, the tilted bellhousing was designed for a mechanical clutch linkage, but from 1984 to 1992, the tilted bellhousing was designed for a hydraulic clutch linkage. Both types can be used for a C2 conversion, but the 1983 bellhousing is the easiest to use because the clutch fork pivot ball is in the correct place for a mechanical linkage. Since the Camaro bellhousing has the clutch fork exiting at a different angle than the stock C2 clutch fork, some minor fabrication is required for the link that connects the C2 Z-bar to the clutch fork.

For ebay searching, the casting number of the 1983 bellhousing is 14060627, and the casting number of the 1984-1992 bellhousing is 14072723. A photo of the tilted 1983 bellhousing is shown in Figure 4 below.

Fig. 4: 1983 Camaro tilted bellhousing (photo by CF member Tom Austin)

Figure 5 is a photo showing how Tom Austin modified the link between the stock C2 Z-bar and the 1983 Camaro clutch fork. This solution included the use of a Heim joint where the pushrod connects to the stock C2 Z-bar.

Fig. 5: C2 clutch linkage modification for 1983 Camaro bellhousing (photo by CF member Tom Austin)

Figure 6 is a photo that shows where the tilted bellhousing places the T5 shifter in a C2. Note that some amount of cutting was necessary to enlarge the shifter opening to clear the T5 shifter tower. I think that additional few degrees of tilt would center the shifter tower in the C2 opening a bit better and reduce the required amount of tunnel cutting, but the fixed tilt of the Camaro bellhousing gets the shifter in the general area where it needs to be in a C2.

Note that in this installation, a Camaro T5 was used, and the shifter came out slightly farther back than desired. As the photo shows, the offset shifter handle is a pretty simple solution for this problem. An alternate approach is to use a Mustang T5 tailhousing, which places the shifter about 1.5” farther forward than the Camaro tailhousing. This would further reduce the amount of tunnel cutting required.

Fig. 6: Camaro T5 and 1983 Camaro bellhousing used in a T5 conversion (photo by CF member Tom Austin)

An alternate method for tilting the transmission is to make a simple adapter plate that fits between the transmission and the bellhousing. The adapter plate has a set of holes for mounting the adapter plate to the bellhousing, and a second set of holes (rotated about 19 degrees) that mount the transmission to the adapter plate.

There are three advantages to using the adapter plate method. First, this method lets the C2 owner retain their existing C2 bellhousing and clutch linkage. Second, the exact tilt of the transmission is not restricted to 19 degrees, and can be fine-tuned to get the T5 shifter exactly centered in the C2 shifter opening. Lastly, the adapter plate method can accept either a Camaro or Mustang bolt pattern for the T5 case. This expands the supply of candidate T5 transmissions, because used Mustang T5 transmissions are more plentiful, and less expensive, than used Camaro T5 transmissions.

Option 2: Keep the transmission upright and use an offset shifter

This approach has been widely used in C3 conversions because the C3 has more height available in the tunnel directly over the shifter. Even in the C3, some cutting of the transmission tunnel is usually required, but this

cutting is covered by the stock C3 console. Figure 7 shows a representative C3 installation where the T5 transmission was kept upright.

In the C2, there is less available tunnel height to work with, so this particular implementation may be very difficult to use in a C2. So, far, I have not seen an example of this approach in a C2.

Fig. 7: T5 installed upright (not tilted) in a C3 (photo posted on CF)

For the C2, where the available height over the shifter is very limited, an alternative approach would be to modify the shifter so that it exits out the SIDE of the tailhousing shifter box, rather than the top. I have not seen this done by others, but I am working on a simple method for accomplishing this.

I believe the side-exit method might turn out to be the only way to avoid any modifications of the C2 tunnel when installing a T5 in the upright position. A side-exit shifter modification is part of the method used to modify the TKO-600 transmission for installation in a C2. I suspect that a similar method can be applied to the T5, although some fabrication would be required.

SELECTING THE RIGHT T5 FOR YOUR C2 CONVERSION

Since the T5 was made in so many different configurations for different applications, there are about 200 different versions of the T5 available as used transmissions. Some of these are better suited for a C2 conversion than others. Fortunately, due to the extensive interchange compatibility of T5 parts, it is not essential that the used transmission you purchase have all of the characteristics you desire. Often, one or two simple part swaps can get you the feature set you desire.

Following is my attempt to provide a ***simplified*** road map to help C2 owners gain a basic understanding of the specific T5 features that are of interest for a C2 conversion. I have chosen to divide the discussion into the following general categories:

1) World Class versus Non World Class (WC versus NWC)
2) Gear set
3) Input shaft
4) Front bearing retainer
5) Main case bolt pattern
6) Main case oil fill plug
7) Output shaft height and yoke
8) "Reverse brake" feature
9) Tailhousing

World Class (WC) vs. Non World Class (NWC)

The T5 began production in 1982. In 1986, Borg Warner introduced an improved version called the "World Class" T5. The term World Class was used because this version was targeted at auto manufacturers worldwide. After the introduction of the WC version, the previous version was referred to as the NWC version.

It is important to understand that both the WC and NWC versions were in production simultaneously for several years during the transition. For example, the Camaro began using the WC version around 1986, but the Chevy S10 continued to use the NWC version for several more years.

The WC version had several upgrades including improved bearings that made it stronger, and upgraded synchronizers that improved shifting. For these reasons, I think a C2 conversion should use the WC version.

There are web resources that identify which models and years used the WC version, but an easy way to visually recognize a WC version is to look at the countershaft bearing cap that is visible on the front face of the T5. Figure 8 shows how to recognize the difference:

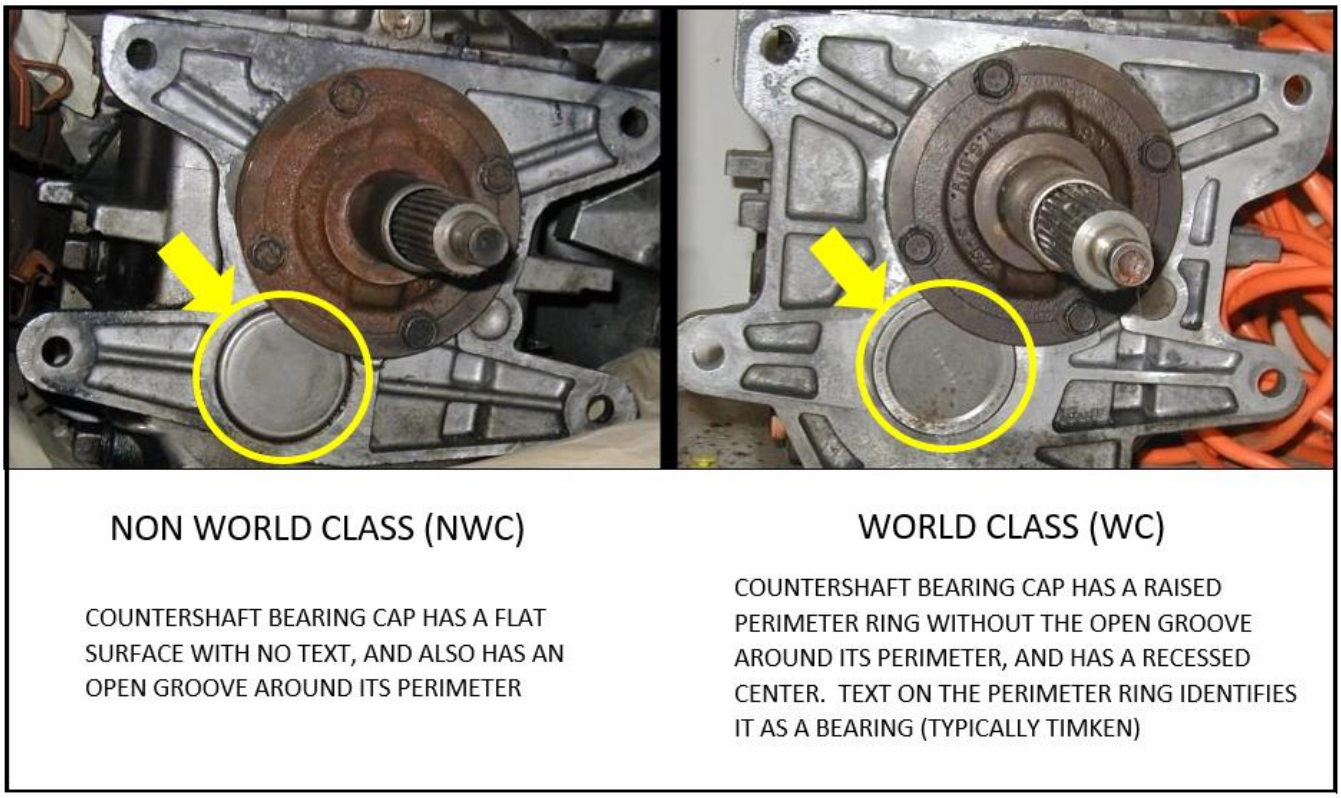

Fig. 8: External identification of NWC versus WC versions of the T5

Gear set

Out of the dozens of gear sets offered in the T5, the strongest were the ones used in V8 Camaros/Firebirds and V8 Mustangs. This helps to narrow the choices.

A further strength improvement was introduced in 1990 for the V8 Mustang gear sets. The metal alloy used for the gears was changed to make the gears stronger, and some fine tuning on the tooth counts was done to add strength. This fine tuning resulted in a very slight change in the Mustang gear ratios. So, with the Mustang gear sets, it is easy to determine which gear set uses the stronger metal alloy, because the gear ratios are slightly different.

I do not know whether the V8 Camaro gear set received the same upgrade to the metal alloy in 1990 that the Mustang received. In terms of strength, following are the two main gear sets of interest, listed in terms of the ratios of the five forward gears:

1986-1992 Camaro/Firebird V8 gear set: 2.95/1.94/1.34/1.0/0.63

1990-1995 Mustang V8 gear set: 3.35/1.99/1.33/1.00/0.68

1999-2004 Mustang V6 gear set: 3.35/1.99/1.33/1.00/0.68

Note that the Mustang gear set listed above should not be confused with the earlier Mustang version that had slightly different ratios of 3.35/1.93/1.29/1.00/0.68. The earlier gear set does not use the improved metal alloy, although it is still quite strong and many people consider it acceptable.

It is useful to note that the 1999-2004 Mustang V6 gear set has the same strength as the 1990-1995 Mustang V8 gear set. This can be helpful when shopping for a used T5, because used V6 transmissions typically sell for less than the V8 versions.

It should also be noted that there were two versions of the Mustang V8 gear set that differed only in the area of the bearing where the input shaft mates with the main shaft. For the special application of the Cobra Mustang, this bearing was changed from the more common arrangement of 15 individual rollers to a tapered roller bearing assembly. This change was made to further improve strength, but it was a fairly rare configuration in production. While any WC T5 can be converted to use this gear set, I believe that the main shaft may have to be changed along with the input shaft.

Lastly, it should be noted that the M-7003-Z T5 that can be purchased brand new through Ford Racing has a unique gear set. The gear ratios are 2.95/1.94/1.34/1.00/0.63, and the input gear uses the tapered roller bearing. The M-7003-Z T5 is generally considered to be the strongest T5 ever built by Tremec (although some aftermarket upgrades claim to make further improvements in strength).

Input shaft

This topic can be quite confusing at first, but the differences are very important to understand when trying to plan a C2 conversion where all the selected components work well together. Ignoring these differences can create unexpected complications when you attempt to install a T5 in a C2. The key things to be aware of are the following differences:

- When measured end-to-end, there are three different lengths of input shafts that can be considered for a T5 V8 application:
    - 8.75” for the Camaro V8 version
    - 9.25” for the 1990-1993 Mustang V8 version
    - 9.875” for the 1994-1995 Mustang V8 and the 1999-2004 Mustang V6
- Ford input shafts use a pilot bearing diameter of 0.668”, while GM input shafts use a diameter of 0.594”.
- Mustang V8 and V6 T5 input shafts are 1-1/16” diameter and have ten splines, while Camaro T5 V8 input shafts are 1-1/8” diameter and have 26 splines. So, both the spline count and the diameter are different. The input shaft on the Ford Racing M-7003-Z T5 has 26 splines, but I do not know the shaft diameter. For reference, the C2 Muncie input shaft is 1-1/8” diameter with 10 splines. So, this means that ANY conversion of a stock C2 from Muncie to T5 will require a different clutch disk that matches the input shaft on the selected T5. Fortunately, only the clutch disk needs to be changed. The pressure plate assembly does not have to be changed.

Fortunately, all of these differences can be accommodated with some advance planning.

Front bearing retainer

The Camaro and Mustang front bearing retainers are physically interchangeable on either the Camaro or Mustang T5 main cases. However, as with differences in input shafts, the topic of different front bearing retainers can also be very confusing. It is important to understand these differences to avoid unexpected problems during installation of a T5:

- The outer diameter of the front bearing retainer, where it bolts to the front of the transmission case, centers the transmission on the bellhousing (and ultimately, on the crankshaft). Accurately centering the

transmission on the crankshaft axis is a key parameter for smooth shifting and transmission life. The base of the Camaro bearing retainer has a diameter of 4.682", while the Mustang front bearing retainer has a diameter of 4.907". So, the Mustang front bearing retainer has a larger diameter than the Camaro version, and will not fit in a GM bellhousing. However, it appears that the Mustang version could be machined on a lathe to match the Camaro diameter.

- The nose of the front bearing retainer is where the clutch throwout bearing slides back and forth. The outer diameter of the Mustang version is 1.436", while the Camaro version is 1.374". So, the correct throwout bearings for use with these bearing retainers will differ.

- Using a Mustang throwout bearing with a Camaro clutch fork is possible, but some trimming of the Camaro clutch fork is usually required to allow free movement of the Mustang throwout bearing over its full travel.

- The length of the nose on the front bearing retainer is shortest on the Camaro version, and longer on the two Mustang T5 versions. When using a Mustang bearing retainer with a GM bellhousing, it will probably be necessary to shorten the nose. Note that the use of an adapter plate between the transmission and the bellhousing will reduce the amount of shortening required.

- In addition to the bearing retainers having different overall lengths, the lengths of the base of the retainer (where the throwout bearing nose enters the base) also differ. This can limit how far back the throwout bearing can travel when the clutch is released. When using an adapter plate with the shorter Mustang version (middle one in Figure 9), the thickness of the adapter plate may solve this problem. The longer Mustang version (right-hand one in Fig. 9) probably can't be used with a GM bellhousing unless the adapter plate is quite thick.

Again, all these differences can be accommodated with some advance planning. Figure 9 shows how the three front bearing retainers compare.

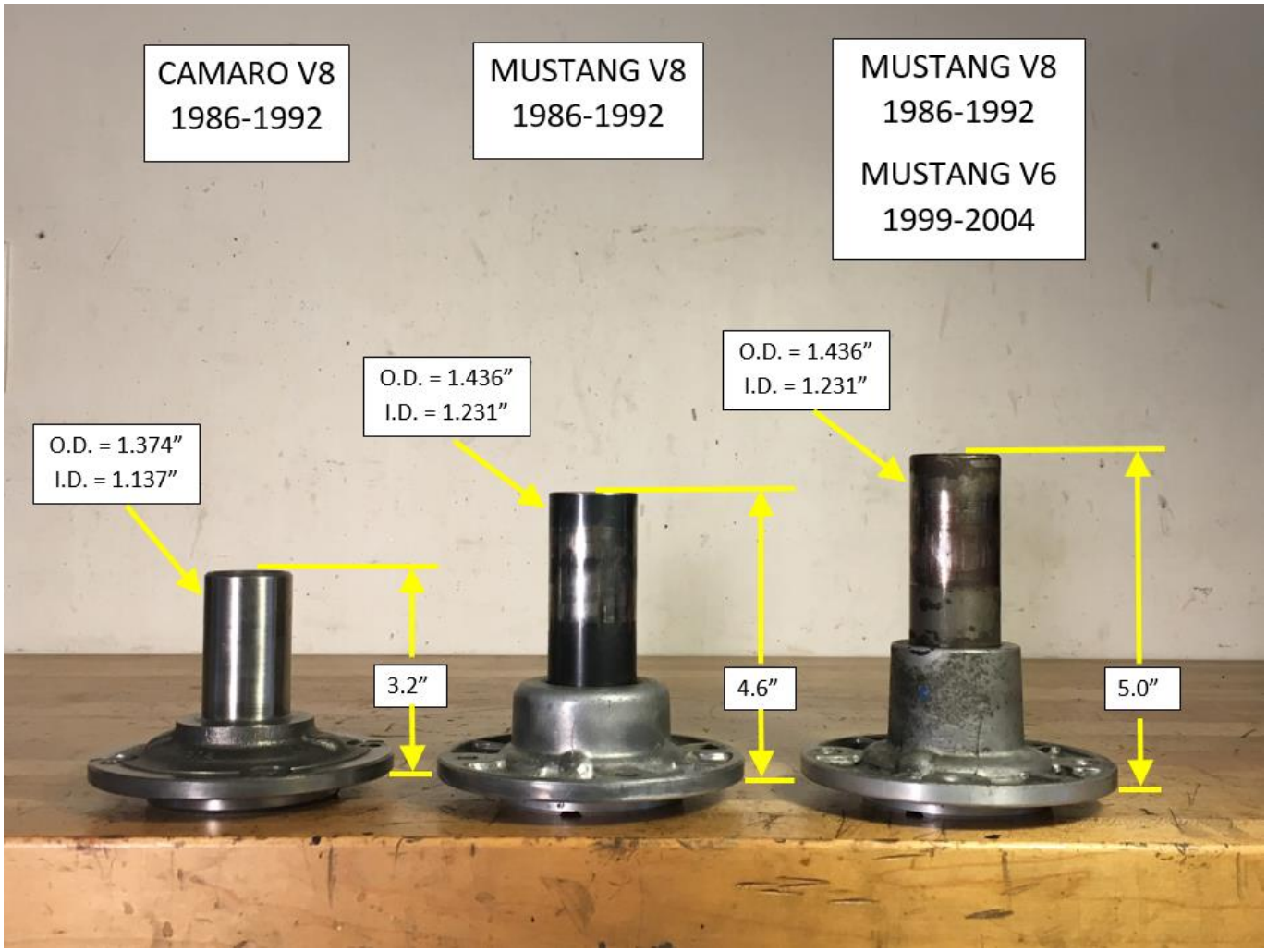

Fig. 9: Comparison of front bearing retainers

For the input shaft itself, there are only limited options for interchange, because the tooth count on the input shaft gears must match. For example, the 9.875” input shaft of the 1994-1995 V8 Mustang and the 1999-2004 Mustang V6 can be replaced with the 9.25” version used on the 1990-1993 Mustang V8 T5, because both versions have 23 teeth on the input shaft gear.

However, it is not possible to substitute a Camaro input shaft in the Mustang gear set, because the Camaro input shaft gear has 24 teeth. At a minimum, this swap would require also changing the cluster gear that mates with the input shaft gear. I suspect that all or most of the remaining gears in the Mustang gear set would also have to be changed to the Camaro versions.

For the Mustang gear sets, the 9.25” input shaft is generally preferred because it conveniently accommodates a 1/2” thick adapter plate for attaching the Mustang T5 case to a GM bellhousing. The longer 9.875” Mustang input shaft requires an adapter plate thickness of 1-1/8”.

Main case bolt pattern

Figure 10 shows a comparison of the bolt patterns on the Mustang main case and the Camaro main case. While the Mustang main case will not bolt directly to a GM bellhousing, it is pretty easy to make an adapter plate.

Stated simply, the adapter plate can be visualized as a 1/2" thick aluminum plate with some holes drilled in it. One set of holes bolts the Mustang main case to the adapter plate, while the other set of holes bolts the adapter plate to the GM bellhousing. In practice, there are some details that require careful attention:

- One of the holes is large and must have a precision-controlled diameter that mates snugly with the selected front bearing retainer. As noted earlier, this matching is necessary for precise alignment of the transmission input shaft to the crankshaft axis. This is the only hole that requires a precision diameter.
- Some of the bolts that attach the adapter plate to the GM bellhousing will have their bolt heads covered by the front face of the Mustang transmission. To allow the face of the transmission to sit flush with the adapter plate, these bolt heads will need to sit below the surface of the adapter plate. The best solution for this problem is to use a flat-head machine screw, with a conical shaped head similar to the common flat-head wood screw.
- Some sort of procedure must be used to align the large hole on the adapter with the axis of the crankshaft. This can be accomplished in several ways, two of which are discussed later in this document.

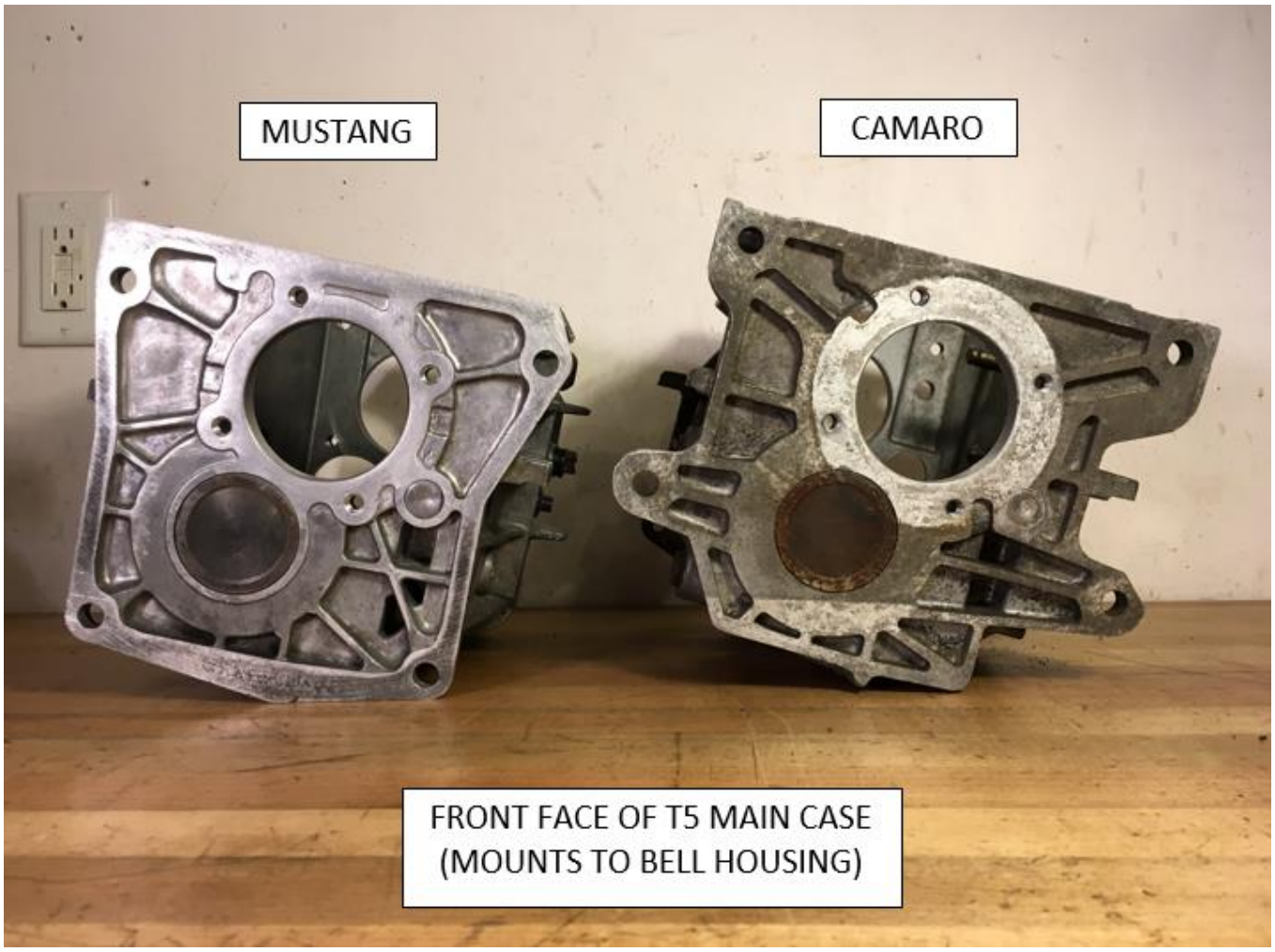

Fig. 10: Comparison of main-case-to-bellhousing bolt patterns

Main case oil fill plug

When GM decided to tilt the T5 for use in the Camaro, one consequence was that the oil fill plug location had to change. Since the standard method for filling a manual transmission is to add fluid until it starts to overflow out the filler hole, tilting the transmission altered how high on the transmission case the filler hole should be.

On the T5, the filler hole is on the passenger side. When the transmission is tilted toward the driver side, the correct placement for the filler hole becomes lower on the passenger side.

Figure 10 shows how the Camaro oil fill plug was moved to support the Camaro's tilted position. Note that on this particular casting, the boss for the upright position is still present. I'm not sure that this unused boss was always present on Camaro main cases. Another thing I am not certain about is whether an unused Camaro boss location appeared on any Mustang main cases.

In any event, I think it would be easy to convert the Mustang case on the left in Figure 10 for use in a tilted application. My approach would be to drill and tap a small 1/8" NPT threaded hole at the correct location for the "oil fill overflow" indication that corresponds to the tilt angle that will be used. This hole would be plugged with an ordinary 1/8" NPT plug. When filling the transmission, both the large oil-fill plug and small 1/8" NPT plug would be removed. Fluid would be added through the large oil-fill hole until it began to overflow out the 1/8" NPT hole. Then both plugs would be re-installed.

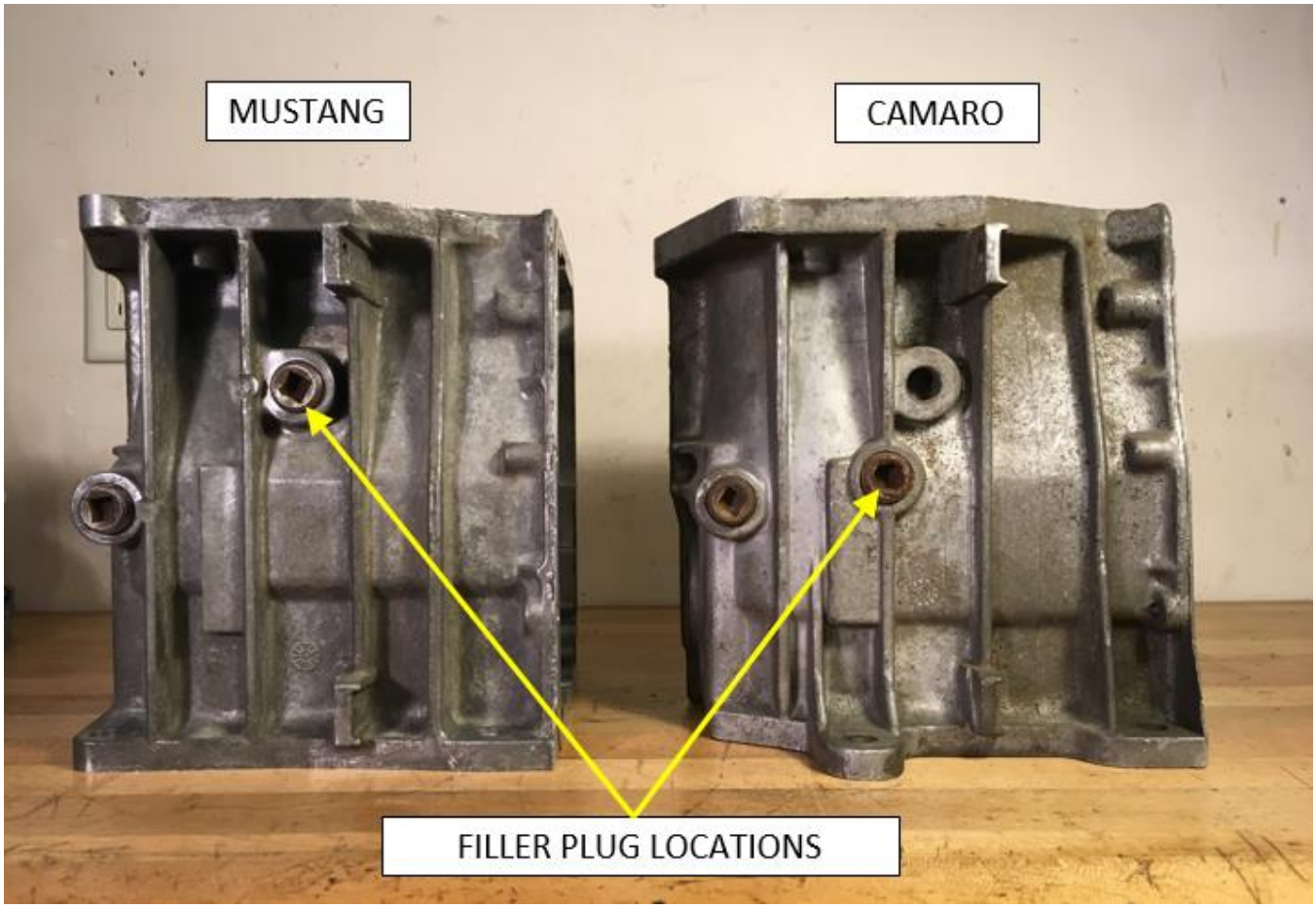

Fig. 10: Comparison of oil fill plug locations

Output shaft height and yoke

Both the Camaro T5 and the Mustang T5 are about 2” longer than a Muncie, so installing a T5 in a C2 requires a slightly shorter driveshaft. Some owners choose to have their existing C2 driveshaft shortened, but for those who want to keep their original driveshaft unmodified, a replacement driveshaft can be purchased or fabricated. Since the TKO-600 is about the same length as a T5, one option might be to simply purchase the driveshaft that Silver Sport transmissions sells with their TKO-600 kit.

The Camaro T5 output shaft has a 1.5” diameter and 27 splines output that matches the yoke used for a C2, so the C2 yoke can be reused. The Mustang T5 output has a 1.5” diameter with 28 splines, so a different yoke needs to be used.

While the C2 transmission yoke attaches the U-joint with removable straps, these straps are not essential for installing or removing the driveshaft. Provided that the driveshaft and transmission yoke are sized to allow the yoke to be pushed into the transmission another 1/2" from the normal operating position, the driveshaft and the attached transmission yoke can be removed as an assembly by unbolting the driveshaft at the differential end. This expands the number of available options for selection of a transmission yoke that can be used with the Mustang T5.

Reverse Brake

Most T5 transmissions have an un-synchronized reverse gear, which is also characteristic of the Muncie transmission and the TKO-600. The main disadvantage of this is that you can get some gear grind when shifting into reverse if the transmission’s gears are still spinning. One common way to avoid this is to push in the clutch, shift into any of the (synchronized) forward gears, and then shift into reverse. For some people, this becomes a learned reflex that they hardly even think about. For others, having to remember this procedure is something they object to.

In 1992, Ford added a “reverse brake” feature to their T5 to overcome this problem. GM never added this feature to their T5.

Some people refer to the “reverse brake” feature as a “synchronized reverse,” but purists point out that reverse is not completely synchronized. The reverse brake feature only works when the car is not moving. If the output shaft is turning, the reverse gears may still grind. However, most people shift into reverse with the car at a standstill, so the reverse brake feature is useful for that condition.

So, if you want the reverse brake feature, your T5 choices must be limited to the 1992-1995 Mustang V8 T5 or the 1999-2004 Mustang V6 T5.

It’s important to understand that when the reverse brake feature was added to the Ford T5, some minor changes were made to both the main case and the tail housing to support this feature. So, if you want the reverse brake feature, you must have the corresponding main case and tail housing too. If you don’t care whether your T5 has the reverse brake feature, you can install an earlier gear set and make some minor modifications to remove the reverse brake provisions from a main case and tail housing that were designed to support reverse brake.

Tailhousing

All of the WC main cases will physically accept any WC tailhousing. Aside from the Mustang “reverse brake” provisions mentioned in the previous section, the only known compatibility problem affecting WC tailhousing swaps is the type of speedometer output (mechanical or electronic) and the location of the speedometer output.

Since swapping the tailhousing is a very simple operation that does not require complete disassembly of the transmission, it is useful to consider the relative pros and cons of the available tailhousings. Following are some key characteristics that are relevant for a C2 conversion:

1) Shifter location (distance back from face of transmission)
2) Installed height of the shifter body
3) Support for a mechanical speedometer
4) Location of the mechanical speedometer output
5) Rear mount location, height, and angle
6) Tailhousing clearance over the C2 transmission crossmember

Figure 11 shows a side-by-side comparison of the Mustang tailhousing and the Camaro tailhousing.

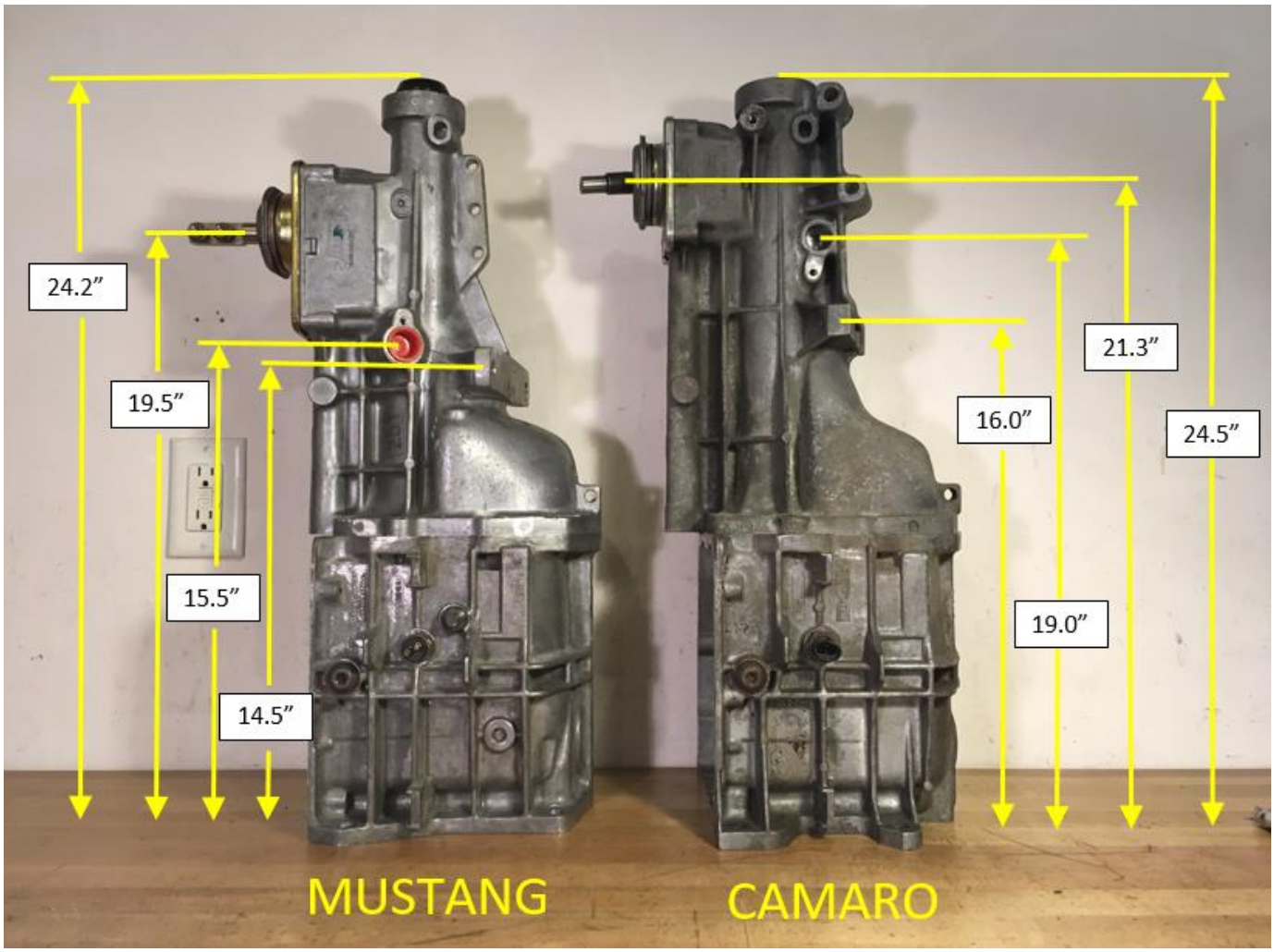

Fig. 11: Comparison of Mustang and Camaro tailhousings

The following table shows a comparison of how certain key dimensions compare for the C2 Muncie, Mustang T5, Camaro T5, and TKO-600.

TRANSMISSION	DISTANCE FROM FACE OF TRANSMISSION (inches)				SHIFTER 0FFSET TOWARD DRIVER (inches)
	SHIFTER LEVER	REAR MOUNT	SPEEDO OUTPUT	OVERALL LENGTH	
Muncie	19.7	14.4	15.2	23.0	2.8 (est)
Mustang T5	19.5	14.5	15.5	24.2	0
Camaro T5	21.3	16.0	19.0	24.5	0
TKO-600 for a C2	20.0	16.0	15.5	24.5	2.5

Shifter location (distance back from face of transmission)

For a C2, the shifter has to be pretty far back on the tailhousing to come close to the location of the original Muncie shifter location. Fortunately, both the Camaro and Mustang T5 tailhousings place the shifter near the shifter opening in the C2 transmission tunnel.

The Mustang shifter location is about 1.8" more forward than the Camaro location, and in this respect it is a better match for the C2 shifter opening. However, since mounting a Mustang T5 on a GM bellhousing requires the use of an adapter plate between the transmission and the bellhousing, the adapter plate will move the shifter rearward by the thickness of the adapter plate.

As seen in Figure 12, the shifter box on the Mustang tailhousing is longer than the shifter box on the Camaro tailhousing. Interestingly, the steel "knuckle" that receives the shifter is longer in the Mustang version than the Camaro version.

As Figure 12 and Figure 13 show, the Mustang and Camaro shifter knuckles appear to be dimensionally identical except for the position of the socket hole that receives the bottom end of the shifter lever. It appears that by simply substituting the Camaro knuckle in the Mustang tailhousing, the shifter position can be moved forward an additional inch from where it appears in the stock Mustang configuration. This change should provide plenty of additional compensation for the thickness of the adapter plate.

Note that if the Camaro shifter knuckle is substituted in the Mustang tailhousing, some minor sheet metal fabrication will be needed to adapt either a Mustang shifter assembly or a Camaro shifter assembly to the revised position.

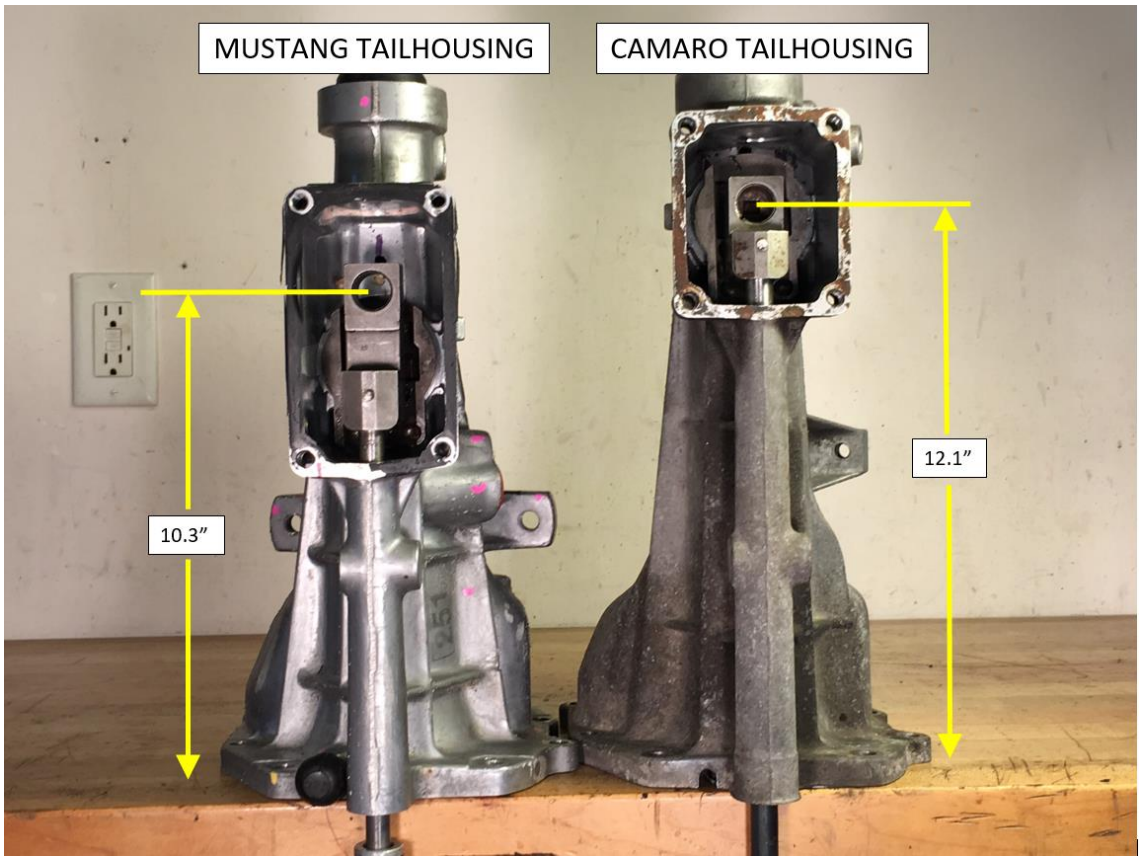

Fig. 12: Comparison of Mustang and Camaro tailhousings

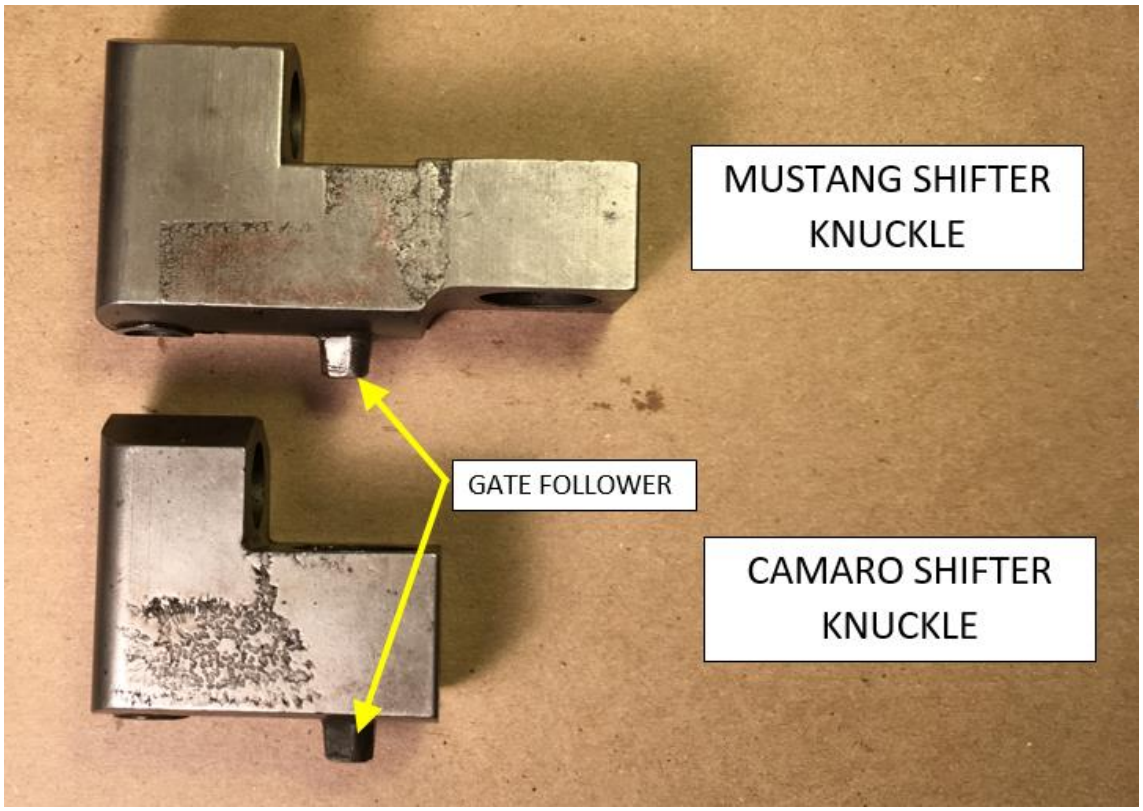

Fig. 13: Comparison of Mustang and Camaro shifter knuckles

Installed height of the shifter body

Aside from the question of how far back the shifter is located on the transmission, another key issue is the installed height of the shifter body. While it is fairly easy to use a dog-leg in the shift lever to alter where the shifter handle comes through the tunnel, some cutting of the transmission tunnel will be required if there is insufficient room to place the dog-leg below the tunnel (see Figure 6 and Figure 7).

One factor that affects the installed height of the shifter body is the installed height of the aluminum shifter box that forms part of the tailhousing casting. Clearly, the higher the top edge of this box, the higher the shifter body will sit.

The overall height of the shifter body is of great interest for installing a T5 transmission in a C2. If the installed height of the shifter body is too high, some cutting of the transmission tunnel will be necessary to clear the shifter body. If the available clearance could be increased enough to allow a shift lever dog-leg to fit under the transmission tunnel, no cutting of the tunnel would be required.

Based on what I have read so far, I have not seen any examples of a C2 conversion that required no cutting of the transmission tunnel. However, as Figure 6 and Figure 7 show, the stock T5 shifter ***almost*** fits without cutting the tunnel. Only a slight increase in tunnel clearance would be required to completely eliminate the need for cutting the tunnel.

For this reason, I have spent some time considering ways in which the shifter could be modified to further increase the tunnel clearance. This analysis is currently underway, so I don't have complete results to report at this time. However, I have some basic measurement information to report that may be helpful for evaluating the feasibility of gaining adequate tunnel clearance with a combination of simple steps.

The shifter height problem is a complex interaction of several factors and tradeoffs. The following things can be done to improve the clearance between the shifter body and the underside of the transmission tunnel:

1) Drop the tailhousing output shaft as low as possible, so that the tailhousing rests just barely above the transmission crossmember. The tailhousing casting can be trimmed to help achieve this.
2) Place shims between the transmission crossmember and the cabin floor pan to push the fiberglass floor up slightly, which will also have the effect of raising the tunnel.
3) Reduce the height of the shifter assembly that sits on top of the tailshaft shifter box.
4) Add some shims at each body mount to effectively raise the entire body higher above the frame.

The problem with simply dropping the output shaft as low as possible it that it alters the angle of the driveshaft compared to the stock C2 angle. Sometimes (but not always), this creates a driveshaft vibration problem. There are ways to help accommodate this by shimming the front differential mount to alter the pinion angle.

Shimming the cabin floor upward is easy to do and can raise the tunnel by up to 1/4".

Compared to the Mustang shifter assembly, the height of the Camaro shifter assembly is about 1/4" lower, as discussed below. Further reductions beyond the Camaro height appear difficult because of the effect on shifter fulcrum length.

Adding shims at the body mounts is easy to do, provided that the body mount bolts are not rusted so much that they can't be backed out a bit. Preparing the body for the shimming process is a bit time consuming because the bumpers need to be removed first, along with the plate where the steering column passes through the firewall. Once the body is free to rise slightly, shims can be added at each body mount.

I added four standard C2 body mount shims (1/16” each) to every body mount on my C2, which raised the entire body by 1/4”. This change is virtually imperceptible when looking at the car. Interestingly, I did not raise the body to install the TKO-600. I raised the body to help clear a hi-rise intake manifold that I wanted to use. However, after the body was raised I went back and lifted the TKO-600 tailshaft further to help improve the driveshaft angles. On paper, my original driveshaft angles were not quite “correct,” but I did not have any problems with driveshaft vibration.

The subject of “correct” driveshaft angles can get quite complicated and I will not go into detail here. I will simply mention that a good rule of thumb is that the driveshaft angles at the transmission yoke and the differential yoke should be equal and opposite, with each in the range of 1 to 3 degrees.

As noted above, the Camaro shifter body height is about 0.25” lower than the Mustang shifter body, as shown in Fig 14. For both the Mustang and Camaro tailhousings, the height of the aluminum shifter box is identical, so the height difference shown in Fig 14 is due entirely to the shifter that is mounted on top of the shifter box.

The Camaro and Mustang shifters are functionally interchangeable, aside from the fact that the sheet metal bases have different footprints. Internally, both shifters use the same components except for the fulcrum lever itself.

The reason that the Camaro shifter body can be shorter than the Mustang shifter is because the fulcrum length of the Camaro lever is shorter than the fulcrum length of the Mustang shifter lever, as shown in Fig. 15.

Compared to the Mustang shifter, the shorter fulcrum length of the Camaro shifter will slightly increase the “shifter throw,” which is the distance that the ball on the top of the shifter (where the user’s hand rests) travels when shifting from one gear to another.

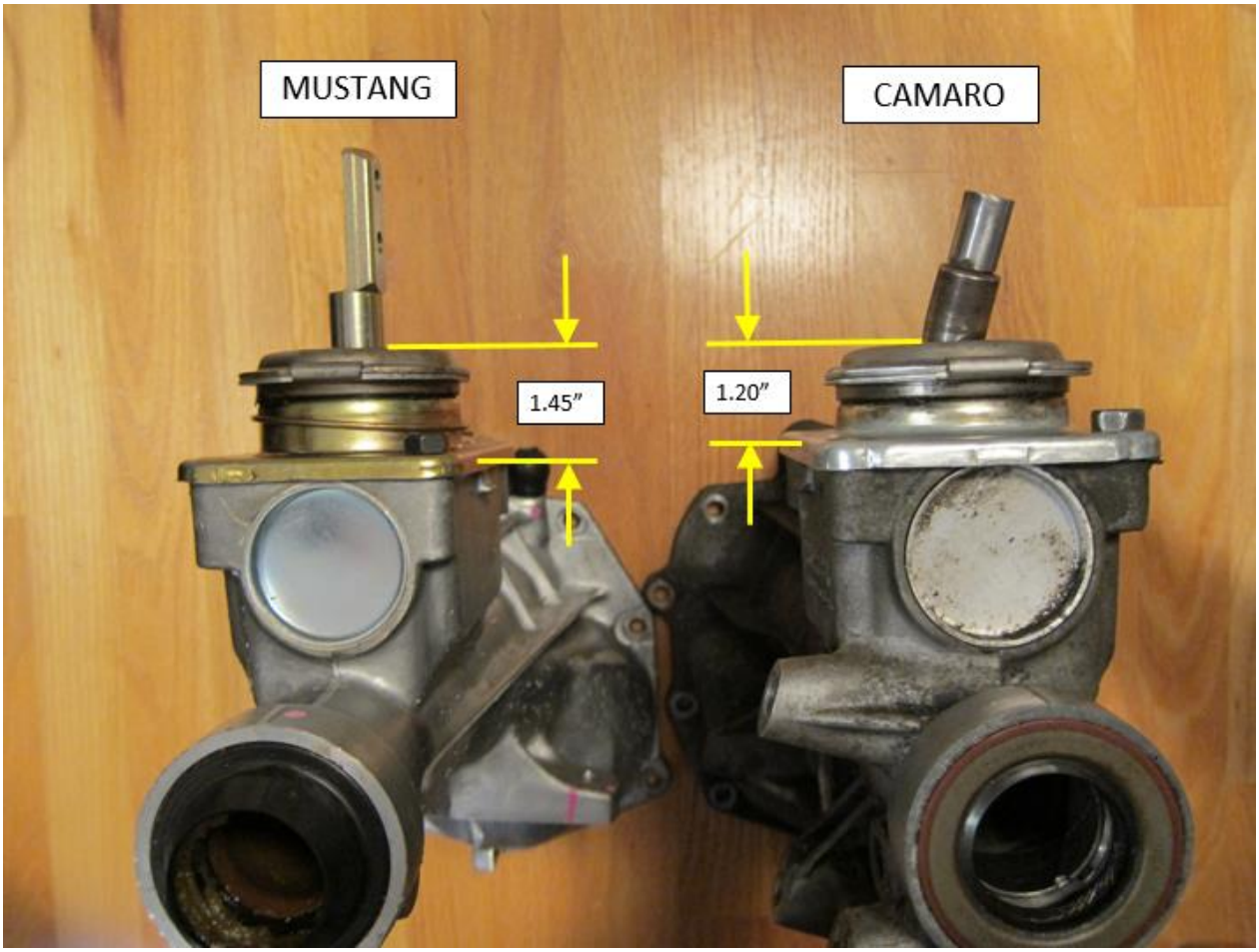

Fig. 14: Comparison of Mustang and Camaro shifter body heights

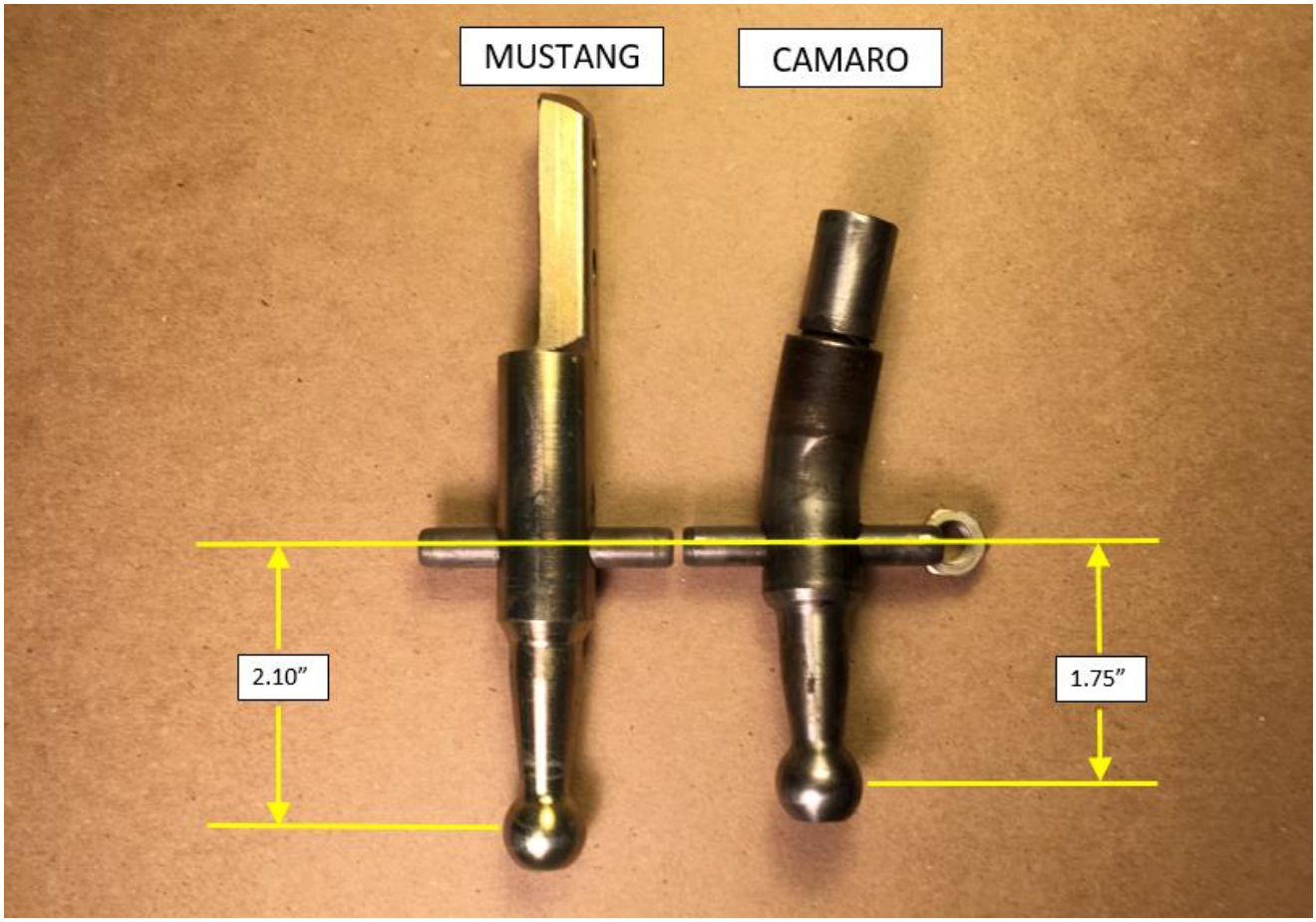

Fig. 15: Comparison of Mustang and Camaro shifter fulcrum levers

To help calculate the available shifter clearance in the C2 tunnel, I have created the following comparison table. The reference dimensions are based on what I can measure on the TKO-600 that is installed in my C2.

Note that my C2 already has the shims under the floor pan and 1/4” of shims at every body mount. So, the measured clearance on my TKO-600 installation is already larger than it would be if the TKO-600 was installed in a stock C2.

On the other hand, my TKO-600 tailshaft sits higher than is physically required to clear the transmission crossmember. So, my TKO-600 tailshaft could actually be adjusted to sit lower than where I have it now, to provide additional tunnel clearance for the shifter box. As noted above, I had no driveshaft vibration problems with my TKO-600 prior to raising the tailshaft further after the body mount shims were added.

	OUTPUT SHAFT CENTERLINE TO TOP OF SHIFTER BOX	TOP OF SHIFTER BOX TO UNDERSIDE OF TUNNEL
REFERENCE CONFIGURATION (Joe’s TKO-600 as-installed)	3.0”	1.5”
T5 TRANSMISSION	3.8”	0.7” (calculated)

The highlighted shifter box clearance of 0.7” is calculated from the measured values of the three other parameters:

Calculated T5 shifter box clearance = 1.5 - (3.8 – 3.0) = 0.7”

Given that even the Camaro shifter body has a height of 1.2", this suggests that it would be very difficult to install a T5 straight-up (not tilted) in a C2 with a dog-leg that fits under the transmission tunnel. The C3 configuration shown in Figure 7 looks tantalizingly close, but this is because the C3 tunnel has more clearance than a C2.

Tilting the T5 helps to point the shifter body toward the C2 shifter opening. Careful study of Figure 6 suggests that the ideal position of the shifter body would be tilted slightly more than the 19 degrees that is built into the Camaro bellhousing. A further improvement would be to move the shifter slightly more forward, by using the Mustang tailhousing and possibly also using the Camaro shifter knuckle in it.

My sense is that these two changes would likely be sufficient for getting the T5 shifter body to come out entirely within the existing C2 shifter opening, so that no cutting of the tunnel is required.

Perhaps the simplest approach for achieving this would be to use a Mustang T5 with a custom adapter plate that tilts the transmission bit more than 19 degrees used in the Camaro. I suspect that increasing the tilt to about 23 degrees would be sufficient.

Lastly, I have not yet given up on finding a way to install the T5 straight-up. It appears that the only way to accomplish this would be to convert the tailhousing shifter box so that the shifter control exits on the ***side*** of the shifter box, rather than the ***top***. This basic approach is what Silver Sport Transmissions uses to move the TKO-600 shifter to the C2 location.

I'm currently evaluating various methods for using mostly off-the-shelf shifter components and some simple fabrication to modify the T5 tailhousing for a side-exit shifter. If I come up with anything that looks useful, I will update this document to provide more details.

Support for a mechanical speedometer

Camaros used a mechanical speedometer up through about 1988, and Mustangs used mechanical speedometers up through 1995. The threads for receiving the mechanical speedometer cable are standard GM in the Camaro, but different in the Mustang. So, to connect a C2 speedometer cable to a Mustang tailhousing, some sort of adapter or special speedometer cable is needed. I have not researched the options but I believe there are readily available adapters.

For the first few years after the Camaro was converted to an electronic speedometer output, the electronic sender was still gear-driven. It is my understanding that these tailhousings will still accept the mechanical output hardware.

One way to simply look at a tailhousing and determine whether it has the ability to accept a mechanical output is to look at the angle of the output device relative to the tailshaft. A sure sign that indicates the tailshaft will ***not*** accept a mechanical output is when the speedometer sensor is pointed directly at the tailshaft. This orientation is characteristic of a fully electronic sensor configuration. Gear-driven senders point tangentially at the output shaft, so that their driven gear sits next to the side of the output shaft. If you see this orientation, there is a good chance that the tailhousing can be configured with a mechanical speedometer output.

Location of the mechanical speedometer output

A related C2 consideration for the mechanical speedometer output is where it is located on the tailhousing. The Camaro output sits directly above the rear crossmember of a C2. With the transmission tilted, the speedometer output points down at the crossmember. This makes it a bit difficult to connect the speedometer cable. Some people have managed to get the C2 speedometer cable to fit, while others have used a right-angle adapter.

The mechanical speedometer output on the Mustang tailhousing is farther forward than the Camaro location, so it avoids interference with the transmission crossmember.

If your conversion plan includes swapping the tailhousing to a different version than what your T5 came with, there is an additional consideration regarding the location of the mechanical speedometer output. Depending on what tailhousing you wish to swap in, the speedometer output location on the new tailhousing may not line up with the existing position for the speedometer drive gear that mounts on the output shaft.

And, if you are trying to combine a Mustang tailhousing with a Camaro output shaft (or vice versa), the drive gear and driven gear will be incompatible. It appears that with some minor fabrication, a Camaro or Mustang drive gear can be mounted at any desired position on a Camaro or Mustang output shaft.

A simpler problem occurs when swapping a 1999-2004 Mustang V6 WC tailhousing onto an earlier Mustang V8 T5. The 1999-2004 Mustang T5 used an electronic speedometer output that was moved much farther forward on the output shaft. However, the original boss for the mechanical speedometer drive gear is still present in the original position on the output shaft. The only thing missing is a small dimple in the drive gear boss for receiving a latch tab that locks the drive gear to the output shaft. This dimple can be added using a carbide burr or drill that is capable of cutting into the forged material of the output shaft.

If you prefer to avoid these types of fabrication tasks, you should avoid using a tailhousing where the mechanical speedometer output is not matched to the drive gear on the output shaft.

Rear mount location, height, and angle

On a Muncie, the rear mount is 14.4” back from the face of the transmission. On the Mustang T5, the rear mount placement is 14.5” back, and on the Camaro T5 tailhousing the rear mount is 16” back. Both the Camaro and Mustang rear mounts are forward of the C2 transmission crossmember, but the Camaro clearance is a bit tight.

It is worth noting that the Mustang rear mount location is sufficiently similar to the Muncie location that the stock C2 crossmember mounting bracket can probably be used as a starting point for fabricating a rear mount. And, the Camaro rear mount location is sufficiently similar to the TKO-600 location that the pre-engineered, bolt-in crossmember mount sold by Silver Sport Transmissions for the TKO-600 can probably be used as a starting point for fabricating a rear mount when using the Camaro tilted bellhousing and tailshaft. The Silver Sport rear mount is the gold-colored bracket in Figure 1.

One reason that the above-referenced off-the-shelf rear mount brackets may require modifications is that the T5 rear mount places the output shaft higher than a TKO-600 (I do not yet know this dimension for the Muncie). On TKO-600, the vertical distance between the rear mount pad and the centerline of the output shaft is about 2.2”. On the T5, this distance is about 3.0”. So, to achieve the same output shaft height using a stock GM transmission rear mount isolator, the mounting surface of the T5 rear mount bracket would have to be 0.8” lower than the TKO-600 position.

Recall that the bellhousing used in the Camaro T5 tilts the transmission about 19 degrees to toward the driver. This helps to bring the shifter box on the tailhousing closer to the C2 shifter opening. As a consequence of this tilt, the rear mount on the Camaro tailhousing is angled at 19 degrees, so that the rear mount will sit flat on a horizontal transmission mount.

While at first the Mustang rear mount appears to be designed to keep the transmission completely vertical, closer inspection reveals that even the Mustang rear mount tilts the transmission toward the driver about 6 degrees. So, a simple horizontal rear mount for the Mustang transmission would require tilting the Mustang transmission 6

degrees toward the driver. Since using any Mustang transmission in a C2 will require an adapter plate anyway, this 6 degree tilt can be incorporated into the adapter plate if desired.

Tailhousing clearance for the C2 crossmember

For both the Camaro and Mustang tailhousings, the C2 clearance is tight in the area where the tailhousing sits over the transmission crossmember. It's worth noting that there are conflicting goals for setting the height of the tailshaft.

For good crossmember clearance and proper transmission-to-driveshaft angles, there is an incentive to raise the tailshaft. However, raising the tailshaft also raises the shifter, and there is very little tunnel clearance for the shifter. Lowering the tailshaft helps with shifter clearance, but can cause the tailshaft-to-driveshaft angle to be less than optimum.

For both the Camaro and Mustang tailhousings, additional clearance between the tailshaft and the crossmember can be obtained by removing some material from the tailhousing where it interferes with the crossmember. Both the Camaro and Mustang T5 tailhousings have provisions for a mount at the very end of the tailhousing. This mount is not used for a C2 conversion, so it can be either completely or partially removed to provide more crossmember clearance.

I have not performed a detailed comparison to determine which tailhousing is better in the crossmember area, but it ***appears*** that the Mustang tailhousing may be marginally better. Note that for both versions of the tailhousing, the clearance issues are different depending on whether the transmission is tilted or not.

BELLHOUSING SELECTION

To attach a T5 transmission to a Chevy small block, there are three basic GM bell housings that can be considered:

1) The 1983 Camaro V8 tilted bellhousing designed for a mechanical clutch linkage
2) The 1984-1992 Camaro V8 tilted bellhousing designed for a hydraulic clutch linkage
3) Any C2-style Chevy small block bellhousing that accepts a Muncie transmission

The 1983 Camaro tilted bellhousing is popular for applications where the owner wants to use the Camaro T5 and tilt it to help bring the shifter out in the C2 tunnel shifter opening. Everything bolts right up to the engine, aside from some minor changes to the C2 mechanical clutch linkage to adapt to the non-stock clutch fork and clutch fork angle.

In theory, the 1984-1992 hydraulic clutch bellhousing could also be used with the C2 mechanical linkage, by simply cutting off the cast-in bracket for the hydraulic slave cylinder. However, note that the hydraulic bellhousing shown in Figure 16 has the clutch fork pivot ball moved outward compared to the 1983 mechanical clutch bellhousing. If the pivot ball remains in this position, it will be necessary to lengthen the clutch fork to get the correct leverage for the C2 mechanical clutch linkage. One source states that some of the hydraulic bellhousings actually have a cast-in boss that can easily be drilled out to relocate the clutch pivot ball to the 1983 location.

There is also the option of using the hydraulic bellhousing as-is, and converting to a hydraulic clutch linkage. Some people have reported that the slave cylinder mounting bracket interferes with the C2 firewall, although this

seems surprising to me. In any event, I'm not much in favor of going to the additional trouble of converting to a hydraulic clutch, when simpler solutions are available that retain the C2 mechanical clutch linkage.

Perhaps the most attractive bellhousing option is to retain the stock C2 bellhousing that was used with the Muncie transmission. A Camaro V8 T5 will bolt right up to the Muncie bellhousing. The input shaft of the Camaro V8 T5 is the same length and diameter as the Muncie input shaft, and uses the same size pilot bushing. The only required change is the clutch disc (not including the pressure plate assembly), since the C2 Muncie input shaft has 10 splines and the Camaro V8 T5 input shaft has 26 splines. Note that later C3 Muncies already have the 26 spline input shaft.

The problem with simply bolting the Camaro T5 to a stock Muncie bellhousing is that the transmission will be sitting upright. This may make it impossible to avoid cutting the transmission tunnel to provide adequate clearance for the shifter body. Another issue is that the Camaro T5 rear mount is tilted at the same 19 degrees as the Camaro tilted bellhousing. So, if the Camaro T5 is installed straight up, some fabrication will be required to adapt to the tilted rear mounting flange.

Lastly, another way to retain the stock C2 Muncie bellhousing is to use the Mustang T5 with an adapter plate between the T5 and the bellhousing. This provides the flexibility to tilt the T5 at any desired angle, and makes it easy to take advantage of some desirable features of the Mustang tailhousing.

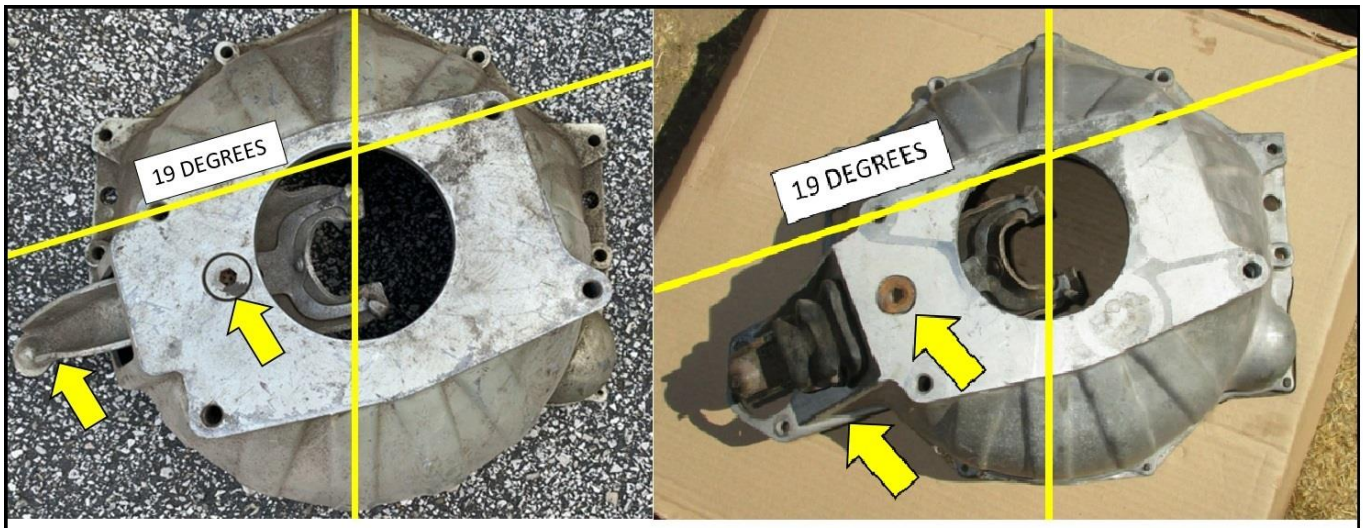

Fig. 16: Comparison of Camaro V8 T5 bellhousings

Regardless of which bellhousing is used (even if the stock C2 bellhousing is being retained), an important step for installing a T5 is to ensure that the transmission input shaft is properly aligned with the centerline of the crankshaft. In theory, proper alignment is ensured by having the bellhousing opening centered on the crankshaft, and then having the front bearing retainer on the transmission fit snugly within the opening in the bellhousing.

The factory design of the bellhousing uses two large diameter dowel pins to align the bellhousing. These dowel pins are installed in the mounting flange of the engine block, and mate with two large holes in the bellhousing flange. The holes in the bellhousing for the bolts that attach it to the block have extra clearance, so that it is the two dowel pins, rather than the bellhousing bolts, that determine the centering of the bellhousing. The attachment bolts provide only clamping force, not alignment.

In practice, the factory C2 tolerances for centering the bellhousing opening on the crankshaft were sufficient for a Muncie, but the T5 (and all modern 5-speeds) are more sensitive to poor alignment with the crankshaft. The potential results of poor alignment are hard shifting and shorter bearing life.

In view of this, it is strongly recommended that the bellhousing alignment be checked, and corrected if necessary, prior to installing a 5-speed. The basic procedure is to use a magnetic base to mount a dial gauge on the flywheel, and then place the dial gauge in contact with the inside surface of the bellhousing hole. Figure 17 shows the basic measurement setup. The crankshaft is then turned by hand to allow the dial gauge to show how well centered the bellhousing hole is with respect to the crankshaft axis.

For a standard GM bellhousing, special offset dowel pins are used to center the bellhousing. The process is not difficult, but it can be a bit tedious.

It's important to note that if an adapter plate is being used between the bellhousing and the transmission, the transmission's front bearing retainer will be indexing with the adapter plate rather than the bellhousing. In this case, the alignment problem can be solved in two ways:

1) Drill and install two small dowel pins in that fix the alignment between the adapter plate and the bellhousing, and then use the standard bellhousing alignment procedure with offset dowel pins installed in the factory locations between the bellhousing and the engine block. The only change to the procedure is that the dial gauge should be checking the inner surface of the hole in the adapter plate, rather than the hole in the bellhousing. This is because the front bearing retainer on the transmission will be indexing with the adapter plate rather than the bellhousing.

2) Leave the factory alignment dowels installed between the engine block and the bellhousing, and assume that the bellhousing alignment may be off a bit. Rather than correcting the alignment by moving the bellhousing with respect to the engine block, simply move the adapter plate with respect to the bellhousing. Once the adapter plate is centered, drill and install two small dowel pins that lock the position of the adapter plate with respect to the bellhousing.

Both of the above methods are functionally equivalent and equally accurate. The method selected can be based purely on the owner's preference.

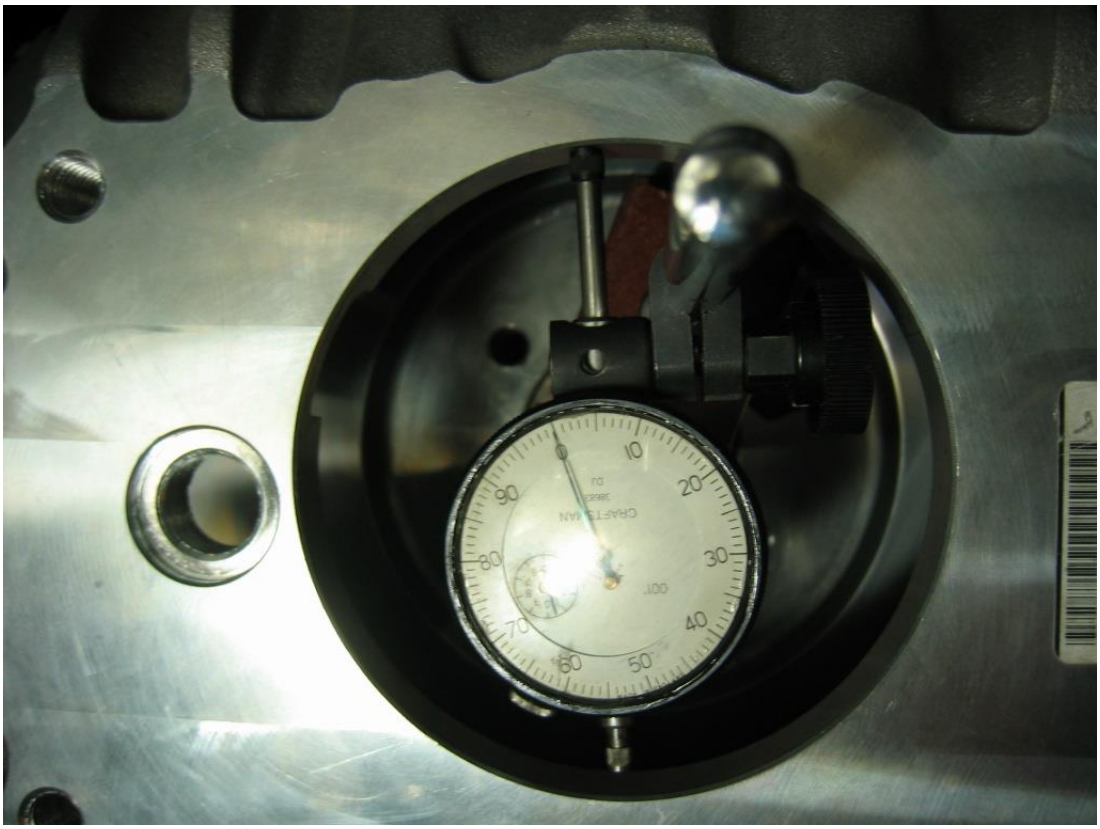

Fig. 17: Bellhousing alignment measurement setup

INSTALLING A T5 WITH THE ENGINE IN THE CAR

Many people believe that to install any 5-speed transmission in a C2, the engine has to be removed. This is based on the belief that the welded-in transmission crossmember in a C2 will prevent the 5-speed transmission from being installed, since the 5-speed transmissions are longer than the Muncie 4-speed that could be installed in a C2 with the engine in the car.

I think this is a misconception. For example, it has been proven that the TKO-600 can be installed in a C2 with the engine in the car. I have done this myself, so I know it is possible. However, the required procedure is non-intuitive and would not be readily apparent to most installers.

Fortunately, the procedure I used for the TKO-600 is well documented in the Silver Sport Transmission TKO-600 installation instructions that are posted on the Silver Sport web site. The "trick" is to place the transmission under the tunnel with the clutch and bellhousing hanging loosely on the transmission input shaft, and then attach the clutch and bellhousing after the transmission has been raised into the tunnel. Given that the T5 is a bit smaller than the TKO-600, I am convinced that the same procedure would work fine for a T5. In fact, the T5 might be even easier to install than the TKO-600.

In terms of the effort involved to install a transmission, I think there is a ***huge*** difference between doing the installation with the engine in the car versus pulling the engine/transmission assembly as a unit. I have done this both ways, and I think removing the engine adds a lot of extra work.

For example, to remove the engine, the radiator, fan, and fan shroud have to come out, and you have to drain the coolant. The fuel line has to be disconnected and plugged. If you have power steering, there is yet another fluid

circuit that has to be opened and plugged. And, if you have air conditioning (as I do), extra steps are required to get the engine out without opening the A/C refrigerant circuit. In addition, several electrical connections and the oil pressure line have to be disconnected from the engine, and the engine mounts themselves have to be disconnected. This all adds up to a lot of work.

In my view, it is far easier to take the extra steps to install the transmission with the engine remaining in the car. These extra steps are much easier if you have a 3-axis transmission jack that allows you to lift and tilt the transmission into various positions and then hold it there while you deal with the clutch and bellhousing. I used a 3-axis transmission jack purchased from Harbor Freight for about $200.

CHOOSING A USED T5 TO START WITH

As I write this in 2019, there are four basic categories of used T5 transmissions that each contain gear sets considered to be strong enough for use behind a V8 engine:

- 1986-1992 V8 Camaro/Firebird (typically about $750)
- 1990-1993 V8 Mustang (typically about $750)
- 1994 - 1995 V8 Mustang (typically about $500)
- 1999-2004 V6 Mustang (typically about $300)

The above price estimates are based on a review of the listings on the nationwide web site for junk yards, www.car-part.com. At any given time, multiple examples of each transmission are usually listed on this web site, so it is possible to quickly get a sense of the current market value these versions of the T5 have.

Asking prices on ebay seem to vary more widely, and usually have additional shipping costs. Perhaps the best deals can be found by patiently watching the local Craigs List listings and the www.car-part.com junkyards that are within driving distance of where you live. Often these sellers are not willing to pack and ship a T5, so their potential customer base is smaller than for ebay, and the asking price may be more favorable than ebay.

All of these are candidates for use as a starting point for a C2 T5 conversion, but the all-in cost of the conversion will depend partly on your overall plan. Following are some example considerations:

- If you want an all-GM solution, you should probably start with a V8 Camaro T5 and purchase a Camaro bellhousing that tilts the T5. Many people has done this with good success.
- The Mustang T5 has some advantages compared to the Camaro T5. For a C2 installation, the Mustang tailhousing has a better shifter position, better rear mount position, and better speedometer output position. The 1990-1992 Mustang V8 T5 is a good choice because the input shaft on these transmissions is 0.5“ longer than the GM input shaft. This extra length conveniently allows for a 0.5” thick adapter plate to bolt the Mustang pattern main case to a standard C2 bellhousing. As an added benefit, the adapter plate allows you to tilt the T5 at any angle you desire so that you can fine tune the shifter placement in the C2 tunnel opening.

- If you want the “reverse brake” feature, you should start with a 1994-1995 Mustang V8 T5 or a 1999-2004 Mustang V6 transmission. However, these versions of the T5 have an input shaft that is about 1.3” longer than the Camaro V8 input shaft. To deal with this extra length, you can use a thicker adapter plate or change to the 1990-1992 Mustang V8 input shaft and keep the adapter plate at only 1/2” thick.

- The “bargain” T5 with the strong gear set is the 1999-2004 Mustang V6 T5. This is a little-known secret that you can use to get a strong gear set at low cost. However, in addition to the extra-long input shaft that this transmission shares with the 1993-1995 Mustang V8 T5, the 1999-2004 Mustang V6 T5 has an

electronic speedometer output that cannot be easily converted to a mechanical output. So, you will need to swap in a tailhousing from an earlier Mustang V8 T5. And, if you want to retain the "reverse brake" feature, this earlier tailhousing will have to come from a 1993-1995 Mustang V8 T5.

THREE SAMPLE CONVERSION STRATEGIES

Option 1: Camaro T5 combined with a 1983 Camaro tilted bellhousing

This strategy uses the tilted Camaro bellhousing combined with a Camaro V8 T5. The transmission and bellhousing bolt right up to the C2 engine. Some minor clutch linkage modifications need to be made to adapt to the fact that the clutch fork exits the bellhousing at a different angle than the stock C2 bellhousing.

Some advantages of this strategy are that the Camaro input shaft is compatible with the Muncie pilot bushing (although the spline count requires a different clutch disc), and the Camaro output shaft is compatible with the C2 yoke. Also, the mechanical speedometer output is compatible with the C2 speedometer cable threads.

Some disadvantages are the typically higher acquisition cost for a good used Camaro V8 T5, the more challenging locations of the rear mount and speedometer output, and the fact that the transmission tilt angle is not adjustable.

Option 2: Mustang T5 tilted using an adapter plate on the stock C2 bellhousing

By substituting a custom adapter plate for the tilted Camaro bellhousing, a Mustang T5 can be attached to the stock C2 bellhousing.

Compared to the previous strategy, one advantage of this approach is that the existing C2 bellhousing and clutch linkage can be retained. Other advantages are more favorable locations for the shifter, rear mount, and speedometer output. Lastly, the amount of transmission tilt can be set at any desired angle using the custom adapter plate. This can help with getting the shifter position optimized.

The main disadvantage of this strategy is that it requires development of a custom adapter plate. This may seem like an intimidating task, but the adapter plate is simply a piece of aluminum plate with some holes in it. The placement of these holes has to be done carefully, but with some patience it is not a difficult task. Other minor disadvantages of this strategy are having to change the pilot bushing and the output yoke, plus having to adapt the C2 speedometer cable to the Mustang output.

Option 3: Mustang T5 or Camaro T5 installed straight up on the stock C2 bellhousing

At present, it does not appear that a T5 can be installed straight-up in a C2 without having to cut the transmission tunnel to clear the shifter body. If the shifter height constraint could somehow be eliminated, mounting the transmission straight-up would be very attractive.

The Camaro T5 would bolt right up to the stock C2 bellhousing and would work with the C2 clutch linkage (only the clutch disc would need to be changed due to the different in the spline count of the input shaft). This simple change is needed for installing any T5 in a stock C2.

Alternatively, a Mustang T5 could be installed straight-up on the stock C2 bellhousing, using an adapter plate. This approach provides the advantages of the Mustang tailhousing, as well as the option for getting the "reverse brake" synchronizer that was available in the Mustang T5 but not the Camaro T5.

For this method of using the Mustang T5, the adapter plate can be an off-the-shelf adapter. Several companies that cater to builders of vintage hot rods sell adapters for attaching a Ford transmission to a GM bellhousing. One example is shown in Fig. 18.

Fig. 18: Off-the-shelf adapter for attaching a Mustang T5 to a GM bellhousing

SUMMARY

To my knowledge, the only pure bolt-in solution for putting a 5-speed in a C2 Corvette is to use a specially modified version of the Tremec TKO-600 (or TKO-500). Complete kits to make this conversion are sold by vendors such as Silver Sport Transmissions. These kits are very well engineered and they bolt in with no modifications to the transmission tunnel or the transmission crossmember. And, all the necessary parts are included with the kit. The only down side is that these kits cost about $4,000.

I was surprised to learn recently that some Corvette Forum members had managed to install a T5 5-speed in a C2 Corvette. The T5 is a very good transmission that has been in production for about 30 years. Used T5 transmissions can be purchased for as little as $300, and a complete C2 installation can be implemented for under $1000. This makes it an attractive low-budget alternative for installing a 5-speed in a C2.

I had always assumed that the problem of shifter placement on the T5 could not be overcome without major modifications to the C2 tunnel and/or the T5 tailhousing. Once it was brought to my attention that some clever methods have been developed to overcome the shifter placement problem, I began reading old threads on this topic in the C2 and C3 groups on Corvette Forum. I found the information to be fascinating.

Some of those threads go all the way back to 2004. These threads contain a lot of valuable insights and suggestions, but the information is scattered widely among multiple long threads. In addition, many of the photos posted in the earlier threads were hosted on outside servers such as tinypic.com and phtotobucket.com, and are no longer accessible.

My intention for writing this paper has been to gather, in a single document, a summary of all the key issues that must be addressed, and the various known methods that others have come up with to address these issues. As far as I can tell, no one has yet managed to install a T5 in a C2 Corvette with absolutely no cutting of the transmission tunnel, but some solutions come very close to meeting that goal.

Based on my review, it ***appears*** that one possible "no cutting" solution would be to use a Mustang T5 and tilt it at about 23 degrees (compared to 19 degrees used in the Camaro bellhousings). With reference to the Camaro T5 installation shown in Figure 6, I believe these two changes would bring the shifter body forward and also toward the driver. This ***might*** allow the entire shifter body to protrude through the stock C2 shifter opening.

Regarding the possibility of installing the T5 straight-up as shown in the C3 installation in Figure 7, my preliminary conclusion is that there isn't enough room to do this in a C2 using a top-mount shifter. Currently I am evaluating some possibilities for converting the T5 shifter so that it exits the ***side*** of the shifter box, rather than the ***top***.

At first this might sound silly, but the same basic approach is used by Silver Sport Transmissions (and other vendors) to move the TKO-600 shifter so that it comes up in the stock C2 shifter opening. If I come up with anything useful, I will add to this document.

In the meantime, if anyone reading this summary has suggestions for improving it, please let me know.

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Corvette Forum member: GearheadJoe
NCRS member: 37610

APPENDIX A: USEFUL WEB LINKS RELATED TO THE T5

Following are some links to web sites and Corvette Forum discussion threads that contain useful information related to the topic of installing a T5 in a C2 Corvette:

http://www.pro-forceperformance.com/t-5_history.htm

http://www.pro-forceperformance.com/t-5_interchange.htm

https://lugnutz65chevystepside.weebly.com/t5-info-page.html

https://www.corvetteforum.com/forums/c1-and-c2-corvettes/4313763-for-those-with-5-or-6-speeds.html

https://www.corvetteforum.com/forums/c1-and-c2-corvettes/1461780-t5-in-63-a.html?referrerid=287484

https://www.corvetteforum.com/forums/c3-tech-performance/1201254-my-auto-to-t5-conversion.html

https://www.corvetteforum.com/forums/c1-and-c2-corvettes/2964232-t5-install-in-my-66-a.html

http://www.mustangandfords.com/how-to/drivetrain/1506-everything-you-ever-wanted-to-know-about-the-t-5-five-speed

https://www.corvetteforum.com/forums/c1-and-c2-corvettes/2964232-t5-install-in-my-66-a.html

https://www.corvetteforum.com/forums/c1-and-c2-corvettes/3344016-t5-5-speed-install-done.html

http://www.britishv8.org/Articles/Borg-Warner-T5-ID-Tags.htm