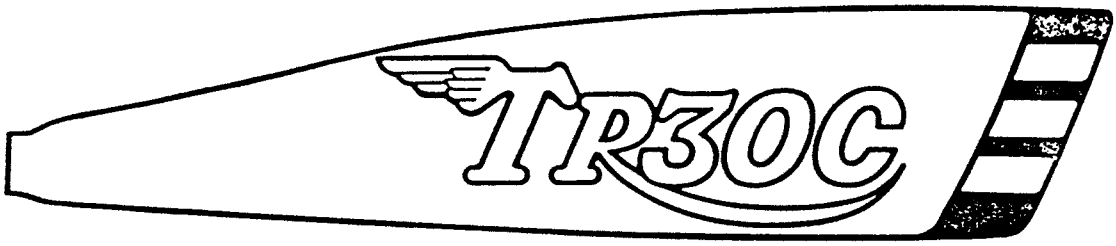


THE CLUTCH - HOW IT WORKS AND HOW TO KEEP IT WORKING.

THE CLUTCH

Tim Smithells, Feb 83

The triple clutch is no more complex than any other motorcycle clutch but it is certainly different - as a result there is an awful lot of misinformation around concerning it. However, those faults not due to initial bad assembly at the factory are mostly due to equally bad home mechanicry, and once the causes of these faults are known and the unit has been rebuilt properly, there should be no need to touch it again except during periodic engine rebuilds.

First, let's examine how it works.

The drive from the crankshaft is transmitted through a chain-and-sprocket set contained within the outer primary transmission casings. The clutch sprocket contains the shock absorber rubbers. The clutch itself runs dry and is contained within the inner part of the casings; a shaft extends from the clutch, protruding into the outer chaincase, and the clutch sprocket unit is a splined fit over this shaft.

The drive is transmitted to the gearbox from the unit via the clutch hub, which is a toothed hub fitted to the gearbox mainshaft by a locknut and woodruff key.

Referring to the main diagram;

1 is the DRIVEN plate. It is made of friction material and is toothed on the inside diameter. These teeth are in permanent engagement with the clutch hub, 2.

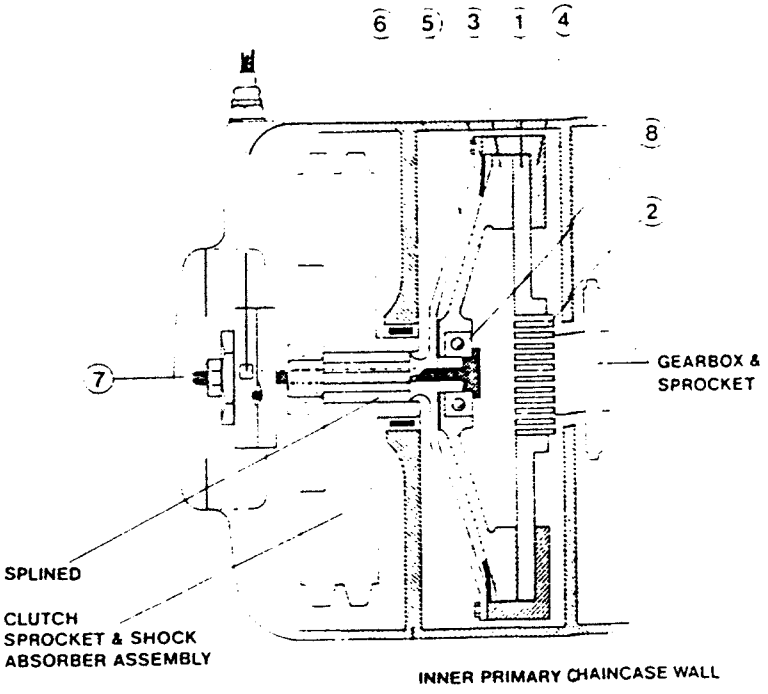
3 is the DRIVE plate. It has lugs which slide in slots in the clutch drum sides (4).

5 is the diaphragm spring. 6 is the end cover, which holds the two plates and the spring together under pressure. It is secured to the drum by twelve bolts around the outer edge.

To disengage the clutch it can be seen that the drive plate has to be pulled away from the driven plate against the pressure of the spring. This is done by the pull-rod and ball-and-ramp mechanism. The pull rod, 7, bears against the centre of the drive plate; as the rod is static and the plate is moving, a bearing (8) is essential. This bearing relies on grease packed during its construction for lubrication.

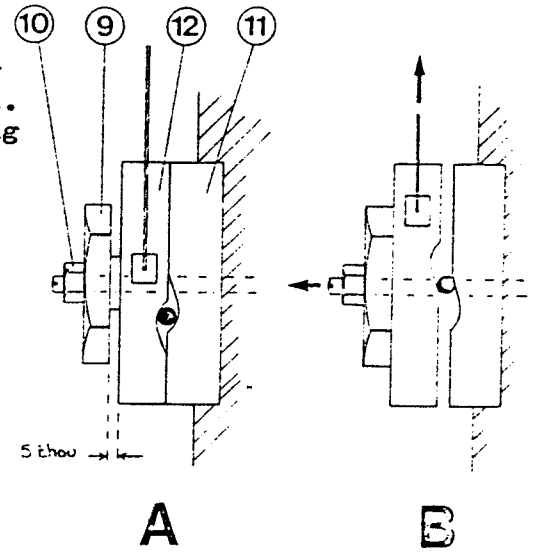
The pull rod passes through a tunnel in the clutch cover shaft, through the clutch sprocket assembly, through the ball-and-ramp mechanism and into a threaded nut (9) which is secured by a locknut (10). See sketches A and B.

11 is fixed into the outer chaincase wall, 12 is moveable. Three ball bearings are sandwiched between the two. When you pull on the cable which is connected to the arm on 12, you therefore pull 12 anti-clockwise. By comparing sketches A and B you can see what happens. In A, the clutch is engaged and the pull-rod is slack. The gap between the nut 9 and the side of 12 represents the clearance gap; the owner's handbook says 5 thou but experience has shown that this is too much. A better method of adjustment is described later on.



Obviously a clearance here is vital, as it is your guarantee that the fast-moving bearing is not being held tight against the static rod. The rod must only make contact with the bearing during the time the clutch is actually being disengaged.

In sketch B the cable has been pulled, and this has rotated the outer half of the unit (12) anti-clockwise. This forces the balls up their ramps which in turn pushes 12 outwards until it contacts the nut 9. As this action continues, the nut, and therefore the pull rod, is forced outwards. The rod contacts the drive plate and the clutch is then freed.



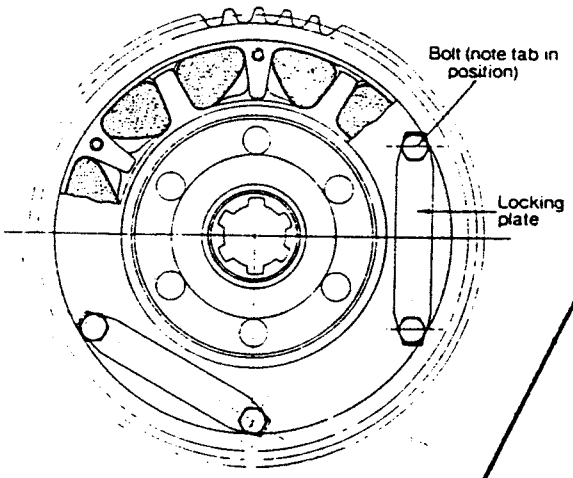
Shock absorber unit

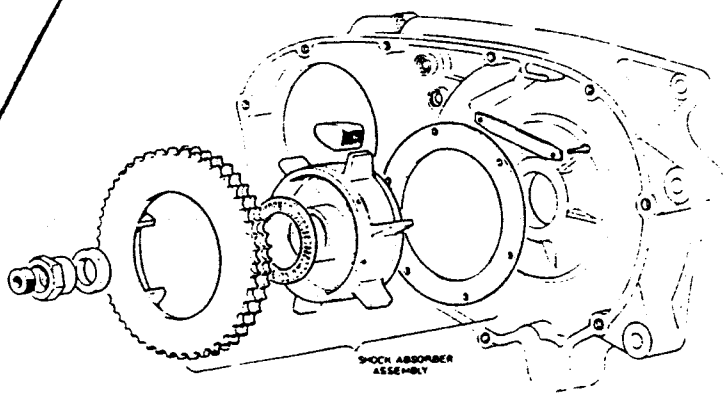
A look at the sketch below will show how the unit fits together. A T160 is shown but all models are similar in principle. The very early triples have a different type of rubber and cover as explained later.

There is a myth that the s/a rubbers are dissolved by oil. This is rubbish - the fact that a 'paste' of oil and destroyed rubbers is found on stripping a faulty unit merely reveals the end result of a mechanical fault.

A set of s/a rubbers should last a minimum of 15,000 miles; premature failure is due entirely to poor manufacture of the unit. It is in two halves, an inner 'spider' and the outer part combined with the sprocket. Each half has six vanes, and the two halves mesh together with a rubber between each vane. The fault lies in the clearance between the tips of each vane and the opposing halfs body; there should be a maximum gap of around 20 thou (minimum 5 thou). Unfortunately triples of all ages, especially T160's, have suffered from poor construction and clearance gaps of over treble the maximum have been recorded. The result of this is that the rubbers, under constant compression and load, are literally squeezed through the gaps. As the vanes have sharp edges the rubbers are rapidly cut to pieces.

The cure is simple - build up the vanes with weld and file to the appropriate clearance.





Problems_

1)- the well known 'knock'. This is a steady knock or chatter coming from the clutch. It is noticed when the motor is ticking over or if you pull away in first extremely sharply. It goes away once the clutch is disengaged or if revs are increased.

There are various causes of this and in NO CASE should it simply be ignored. It will not 'go away', and although it may not seem to become worse past a certain level over a fairly long period, it will be obvious from the following descriptions that the logical conclusion of allowing the fault to continue to develop will be a breakdown in mid-journey.

The first possibility is that the shock absorber securing nut has come loose; this will be obvious upon inspection. A knock is also a symptom of knackered shock absorber rubbers.

Another cause is wear on the clutch driven plate teeth. They must be greased on assembly with HMP grease and failure to do this leads to a spectacular rate of wear. Regrettably the factory was guilty of this failure and most T160's appear to have been assembled dry. As a result many low-mileage bikes are still in the process of developing this fault.

Yet another cause is that of loose rivets where the splined shaft is fixed to the clutch cover, also on the s/a unit spider.

2)- pull rod breakage. Nine times out of ten this is due to poor clutch adjustment. The bearing is a sealed unit and has only its grease for lubrication; it it not supposed to contact the pull rod unless the clutch is being disengaged. Insufficient clearance will lead to the rod face being held against the bearing all the time, and the heat generated rapidly melts out the grease from the bearing - followed shortly after by bearing failure.

In many cases the clutch will still operate, but as the bearing is no longer working the pullrod is subjected to a vicious twisting action every time it contacts the bearing. This will cause eventual breakage of the rod. If adjustment is really poor, the heat generated can be enough to seize the rod to the bearing face. The rod then winds itself through the adjuster nut until the clutch frees itself.

Misalignment of the pullrod is unusual; remember that most breakages are caused by faulty adjustment!

3)- Shearing of the clutch cover shaft. A major cause of this is due to a manufacturing fault in the shock absorber unit, on some early T150's and also some T160's. When the circular cover is bolted down it bears too tightly on the vanes between the rubbers, and locks them solid. As the two halves must obviously have free and independent movement for the unit to work, any shock absorbing quality will be lost, and the transmission stresses will be transmitted to the clutch shaft causing eventual failure. Check your unit as described later. Occasional fatigue failures have also been noted - if the shaft does shear it can snap the pull rod in the process.

STRIPPING AND REASSEMBLY

Your guide assumes that anyone owning over £1000 worth of bike has spent a tiny percentage of this sum on a decent socket set, ring spanners, allen keys, good quality drivers, a hide mallet etc. If not, you would be advised to do some shopping before attempting to work on a triple.

You will also need a few special tools. An engine sprocket puller will be needed; if you want to make one the holes in the sprocket are 3/8 UNF. A clutch hub puller is necessary if the hub or gearbox sprocket is to be changed - this tool cannot be improvised.

The tool for aligning the clutch driven plate centrally within the drum is also desirable; and for the shock absorber securing nut you will need a long reach 15/16th AF socket. The stock type won't fit over the protruding pullrod, and although an open-ender can be used it is advisable to use a torque wrench on this nut.

Parts _

Some or all of the following parts will need replacing during the course of the job; the part no's given are from the Trident parts lists.

FOR THE CLUTCH UNIT: six tab washers, 57-3720. Thrust bearing, 57-3717 /Borg & Beck 76128. Pull rod, 57-2552. Also a clutch plate if wear is suspected.

FOR THE SHOCK ABSORBER UNIT: twelve rubbers, 57-5001. Three tab washers, 57-3941. Thrust race, 57-3646.

CLUTCH ACTUATING UNIT: Tab washer, T150/R3 57-2474, T160 57-4916. S/A securing nut oil seal, 57-3644.

INSIDE CASINGS: Clutch shaft oil seal, 57-3642. Oil seal,cover to main-shaft, 57-3642. Needle race, 57-3643. Engine sprocket tab washer, 70-8785. Oil pump O-ring, 70-6570. Oil pump pinion tab washer, 71-1353. Inner case gasket. For T160, cross-shaft oil seal 60-4504 and tab washer 57-4929.

OUTER PRIMARY CHAINCASE: Needle race, 57-3643. Gasket, T160 71-1454. T150/R3, 71-1454 plus small joint washer 71-2793.

GEARBOX SPROCKET: O-ring 71-1070.

Purchasing the parts catalogue is most advisable as it shows clearly how each part functions and can be used as an assembly guide.

Dismantling the unit

All models are similar in principle. The T160 has a duplex chain and the s/a unit cover faces the inside, also a left-foot shift is fitted; otherwise they are identical. If you have a T160 workshop manual (J.Nelson Pubns) do not follow the instructions in C5 for aligning the gear pedal as these are wrong.

To begin with, place the bike in top gear. Drain off the chaincase oil by undoing the drain plug, remove the footrest, and slacken the primary chain adjuster completely.

Now remove the inspection cover. Slacken off the cable and remove it. Hold the adjuster nut, release the locknut and remove both from the pull-rod. There is no need to dismantle anything else in this area, nor need T160 owners remove the gearshift pedal, unless you wish to inspect the components of the actuating unit.

Now remove the outer chaincase; before doing this T160 owners should read the section on gearshift alignment further on. Slacken off the screws in a diagonal pattern and remove them. Break the gasket joint by giving the cable adjuster a gentle tap with a hide mallet; the case can then be worked free by hand. Expect some oil spillage.

T160 - remove the cross-shaft quadrant. Use a ring spanner on the rather slim nut.

Knock back the tab washer on the engine sprocket. Lock the sprocket by wedging a piece of wood between the chain and sprocket, then undo the nut. Now undo the s/a securing nut, remembering to test it for looseness first - it should require a very firm heave to free it, and if it comes easily then this could explain a clutch knock.

The engine sprocket should be removed with a puller; the clutch sprocket should slide off its shaft quite easily. The chain and sprockets must be removed as a set.

T160 - knock back the tab washer securing the plate and cross-shaft sleeve, then remove the two bolts and the various parts.

Knock back the tab washer securing the oil pump pinion then remove the nut; the pinion is a taper fit on its shaft. Then remove the idler.

Remove all screws and bolts holding the inner casing, once again undoing them in sequence to avoid warping the casing. The case can then be removed. It is awkward but can be done without using a metal object to hit it with!

Remove the clutch unit - don't hold it face up or the pull rod will drop out; remove the rod and put it aside. If the gearbox sprocket or the clutch hub are to be changed the hub must be removed using the special puller; remove the nut, screw in the puller then apply a spanner to the puller bolt. Lock the hub by spragging the rear chain with a piece of wood.

Unscrew the three screws securing the clutch housing. On the T160 detach the leads from the starter motor;the housing can then be removed complete with the starter motor.

Each clutch component must now be inspected as described below.

Clutch unit -

Before dismantling, scribe-mark the relative positions of the drum, cover and driven plate; the unit was balanced at the factory and each of these parts should be replaced as they came out. If one is renewed this may affect the unit and could lead to excessive vibration. For this reason it is best to have the unit re-balanced if time allows.

Spread clean paper on the bench and wash your hands before handling the clutch plate faces. Bend back the tab washers and undo the twelve bolts, turning each one turn at a time to avoid warping the cover.

Having removed the cover, take out the spring and the two plates. The thrust bearing in the drive plate is the most important part of the whole clutch. Its safe working life is a maximum of 20,000 miles assuming the clutch has always been correctly adjusted; if it feels at all rough, if it has leaked any grease, or if the machine is second-hand don't take a chance - renew it. It is not a tight fit and can be drifted out quite easily. Heat is not required.

It should be obvious if the driven plate teeth are worn; these wear far more quickly than the hub but check the hub anyway.

Now reassemble the unit. Fit the driven plate; grease the lugs on the drive plate which slide in the slots in the drum sides and replace it, aligning with the scribe marks. Grease the ridge on the top of the plate lightly, then fit the spring, outer edge up. At this point fit the alignment tool beneath the driven plate and locate the stub in the thrust bearing ; this will centralise the driven plate correctly.

Now fit the cover, making sure the dowel pegs engage with their holes. Fit new tab washers ensuring they are not covering the dowel pegs, fit the bolts then tighten them down one turn at a time until they are all tight; then bend over the tab washers.

Shock absorber unit -

Bend back the tab washers and undo the bolts securing the cover. Turn the unit over, hold it over something soft and thump the central boss with your fist or a hide mallet; the inner spider, rubbers and cover should then drop out.

Assemble the unit without rubbers and check for free movement as explained previously. Also check the vane clearance; the important one is the clearance between the inner spider vanes and the wall of the outer half. The outer halfs vanes do not matter.

To reassemble the unit (with new rubbers, please) fit six rubbers around one 'side'. Then use a pair of molegrips with padded jaws to compress two adjacent vanes with a rubber between them; you can now fit four rubbers around the other 'side' and the final two can be eased in once the molegrips have been removed. Bolt down the cover with new tab washers.

By now most T150 and R3 owners will know that very early models had asymmetric type rubbers and countersunk screws in the cover; most of these bikes will have been converted by now but if yours hasn't been, you should fit the later pattern rubbers and cover.

Other items

Inspect all other parts carefully for wear and replace if necessary. You should NEVER re-use oil seals, always fit new ones. This also applies to the needle roller bearings and the spider thrust race; the bearing in the inner chaincase takes most of the weight of the clutch and s/a unit and it would be foolish not to replace it every time, given the low cost of this.

Reassembling the unit

If you change the gearbox sprocket you must renew the O-ring on the mainshaft. Fit a new oil seal into the clutch housing, lip towards the gearbox. Fit the clutch housing, then refit the hub and torque it to 60 ft lb.

Apply a light smear of grease to the edges of the pull rod boss where it contacts the thrust bearing, then fit the rod in the clutch unit. Also grease the teeth of the hub and driven plate, using 'white' high melting point grease if possible. Fit the clutch over the hub.

Clean the faces of the cases and fit a new gasket, using grease to bed it in - it is totally unnecessary to use any artificial gasket such as RTV on any of the casings. Fit a new bearing and oil seal into the inner casing - the seal should be fitted with the spring side inserted first. Fit a new oil pump O-ring into the case.

Fit the casing, tightening the bolts and screws diagonally and in sequence.

Refit the oil pump pinion and idler gear. Fit a new tab washer and tighten down the pinion securing nut. One tab of the washer should be bent over the nut and the other down into the pinion. T160 only - refit cross-shaft sleeve, plate, tab washer etc.

Primary chain alignment

This is important on the T150 and R3; the duplex-chain T160 is not quite so fussy but owners may still wish to check it just for peace of mind. The alignment must be checked when one or more of the following parts have been replaced:- clutch cover and shaft, shock absorber spider, crankshaft, engine sprocket, oil pump drive.

The alignment cannot be checked simply by placing a straightedge on the sprockets as this must be checked with the clutch sprocket in the running position, i.e. against the thrust face of the outer chaincase cover. The T150 factory manual's method involves the use of a special tool, which costs over £15, and which experience has shown to be difficult to use and slightly unreliable. A dial gauge is also needed. An alternative sometimes suggested is that of using a scrap chaincase cut away to allow access to the sprockets, but quite obviously most people don't have scrap chaincases kicking around.

The only alternative the club has come up with to date is this- fit the engine sprocket without the chain and with any shims fitted previously; make a small ring of soft material, e.g. Blu-Tak, to fit behind the clutch sprocket, then fit the sprocket and its nut, the gasket (do not forget the small central gasket as well as the main one on most models except the T160) and tighten down the case. The soft material should be compressed and push the sprocket into its running position; the chaincase should then be removed carefully and the alignment can then be checked with a straightedge - it must not exceed .010 inches misalignment.

This method is still in the 'experimental' stage and we cannot yet vouch for its accuracy until it has been tested further! However, it's the only apparent alternative to costly tools - other suggestions are welcomed, please write to the magazine Editor.

Owners of early models should read section C9 of the factory manual for information on minor variations in shock absorber construction which may require modification.

Assembling primary transmission

Clean the threads of the clutch cover shaft with petrol, and do the same for the s/a securing nut. Replace the oil seal with a new one, do not attempt to re-use it! Offer up the chain and sprockets as a set, having replaced any shims or spacers removed previously.

Fit the engine sprocket nut tab washer over the crankshaft; bend over the outer edge in two places before fitting as you will find it very hard to do so once the nut has been torqued to the required 60 ft/lb. The tag on the inner diameter of the washer should be engaged with one of the crankshaft splines. When the nut is tight peen the washer over fully.

Fix a twist of Sellotape over the pull-rod threads to protect the edge of the s/a nut oil seal. Apply Loctite and secure the nut, torquing to 80 ft/lb using your long-reach socket. It may be necessary to sprag the chain against the sprocket with a piece of wood - in the writer's experience even a 16-stone rugger player can't hold the T160 brake on past 60 ft/lbs! Refit the cross-shaft quadrant on the T160.

As stated at the beginning of this piece, T160 owners should be reading this before dismantling. Correct alignment of the gear pedal is vital and is done as follows. With the bike in top gear, look through the small hole in the upper l.h. area of the ball-and-ramp unit housing. You will see that the upper edge of the gear-shift gear covers the lower third of the hole - this may vary from bike to bike so take careful note of the exact position of yours; when replacing the outer cover keep the pedal in the same position. If in doubt, as a rule the hole should be slightly LESS than half covered.

Clean the casing faces, fit a new gasket bedded in with grease and offer up the outer casing, making sure the dowel pages engage and that the chain adjuster doesn't foul on the chain. Tighten down the screws evenly and in a diagonal pattern. Fit the clutch cable, adjust the primary chain to 5mm free play and refill the casing with 5/8 pint of engine oil (350 cc).

Clutch adjustment

As you will understand from the first part of this article, the whole point of this adjustment is to prevent the thrust bearing from being overloaded. The original factory suggestion of 5 thou clearance between the adjuster nut and ramp face has proved in practice to be too much, and the method that follows is simpler.

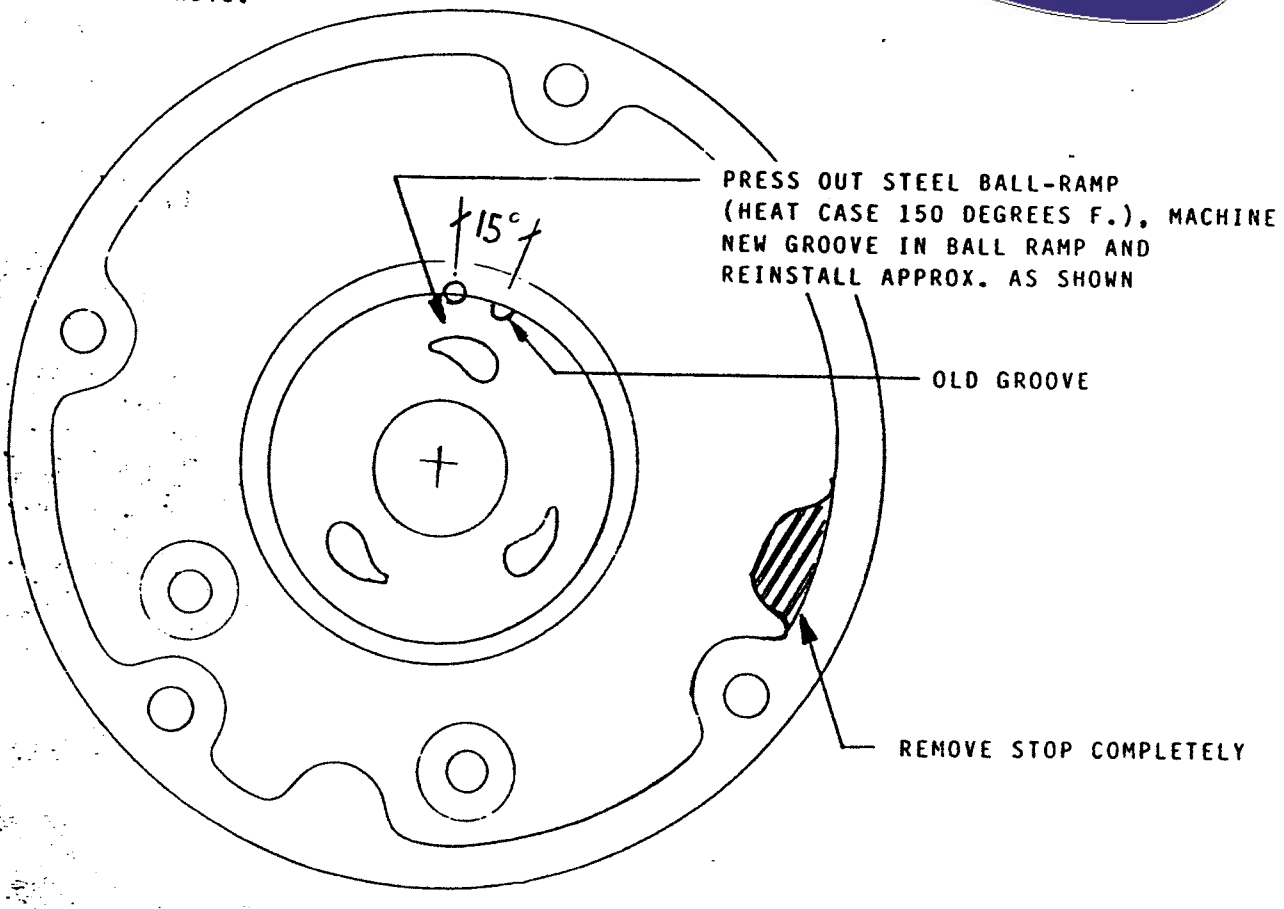
Adjust the cable at the chaincase adjuster, and at the handlebar as well if necessary, until the arm on the actuating unit is between three and four o'clock (but not touching the alloy casing). Screw the pullrod through the adjuster nut until the rod is tight. Now hold the adjuster nut steady and turn the pullrod back about 30 degrees; tighten up the locknut without moving either the pullrod or the adjuster nut. The adjuster nut should now be free to spin round without binding, together with the pullrod, which indicates that the thrust bearing is not under load. When load is applied the bearing will begin to operate, while the adjuster nut will be tight against the face of the ramp - therefore, you should never see the nut move no matter how overloaded it is.

If the nut still feels a bit tight, repeat the adjustment from the beginning with a few extra degrees turn on the pullrod. After the first run, while the engine is hot, check to see if the nut is still free to spin - if not, re-adjust until you are happy.

If renewing the clutch cable fit a 'flexible' type, which, as its name implies, is more flexible and lighter in operation that the standard type. They are made by Venhill and are fairly widely available. A firm called Wicks & Martin made a batch three years ago which kept pulling nipples but these have now all gone. The original factory cable was made by Clarkes of Birmingham, and the Romac replacements available nowadays are of inferior quality, rapidly becoming stiff in operation. None of these cables wish to be oiled, being nylon-lined.

Gary

must be used with modified clutch lever (Barnett lever may be used on early models). Modify stock lever by welding up pivot hole and redrill hole 1/4" further away from cable barrel hole.



T150 CLUTCH RELEASE MOD.

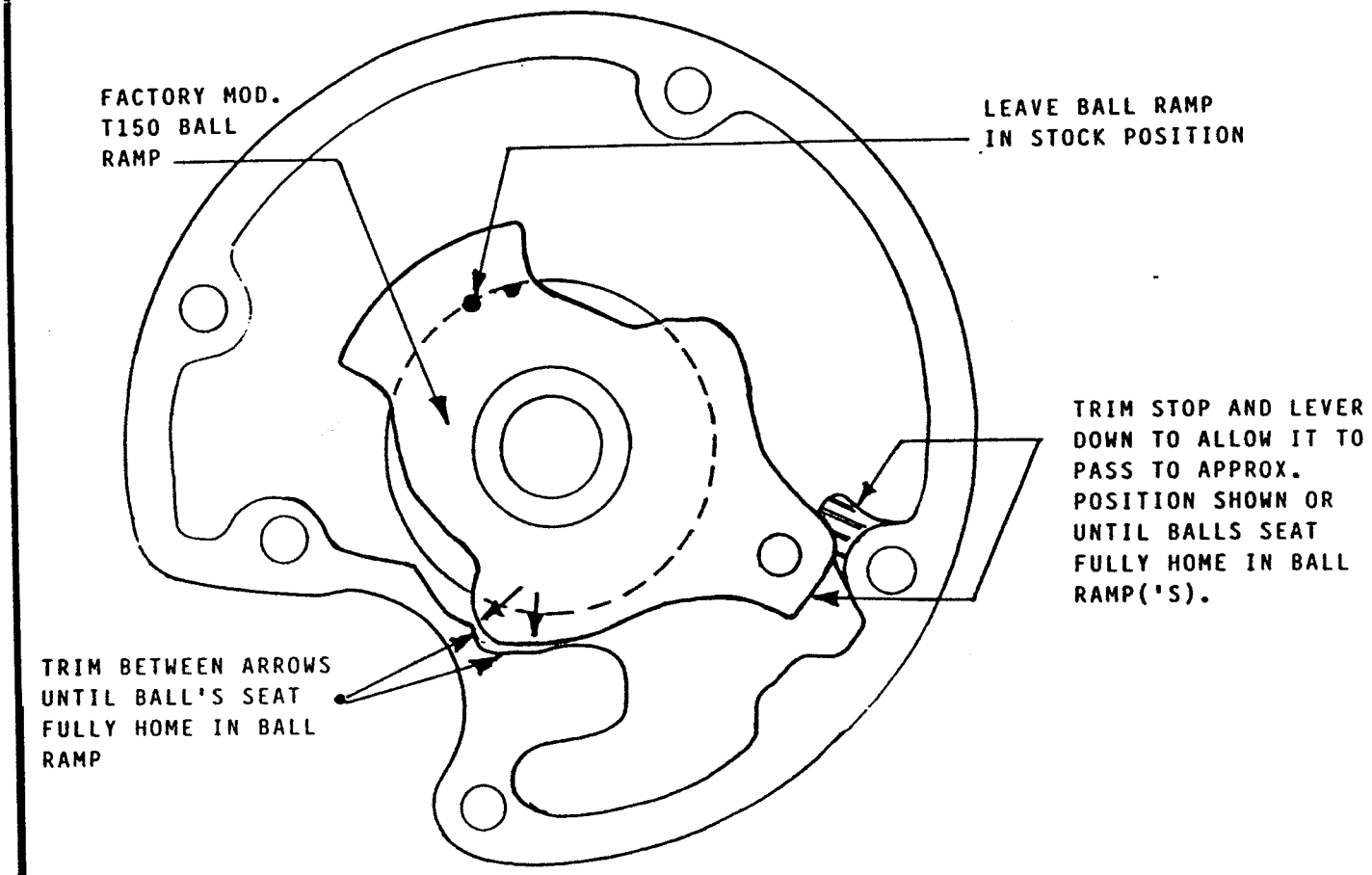
MODIFIED TO REDUCE CLUTCH DRAG AND PREVENT PULL ROD FAILURE.

Tech Tip:

Those of you contemplating clutch work on your T150 or T160 should read the following tech tip. The original idea comes from Jack Wilson's Big D Cycle Catalogs and was submitted to us by member Bill Woodward of Florida. We copied the graphics and added the text. John.

As much as .020 to .030" additional clutch pull rod lift can be gained by modifying the clutch release mechanism, steel ball ramp, handle bar lever, and outer primary cover. While .020" additional lift doesn't sound like enough to bother with; consider that it is equal to 1/5th the total stock lift of .100".

If you have the cover off, the release lever stop boss can be removed with a vertical mill. Or if one is not available a die grinder, with suitable "burr", will do just fine. On the T160 you will have to remove additional material near the shift lever casting area (see drawings).



T160 CLUTCH RELEASE MOD.

Additionally, on the T150, the "ball-ramp" in the primary cover will have to be removed. Heat the case to 150 degrees F. (hot water) and press it out. Then a new groove will have to be machined, 15 degrees counter clockwise to the old one. The ball ramp is hardened and you will have to grind, with a small wheel, a new groove. The T160 the ball ramp can be left in the stock position. Heat the T150 case again and replace the ramp utilizing the new groove.

Assemble the parts, being sure to adjust the pull rod nut to insure a minimum of .005" clearance between the back of the large adjuster nut and the bearing. Too much clearance and it will be impossible to disengage the clutch. Too little clearance and clutch will constantly slip and burn out the inner clutch rod bearing and break the adjusting rod.

You must modify your stock clutch lever by welding up the existing pivot hole and redrill it 1/4" farther away from the cable barrel hole. Or replace the clutch lever assembly with one with a 1 1/8" pivot hole to barrel hole dimension like the Barnett part number 207PA for 7/8" handle bars or if available an Amal or Doherty equivalent.

Finally adjust the clutch cable. You must remember that when the handle bar lever is out, the clutch pull rod must be fully disengaged. The large adjusting nut to bearing clearance must be .005" or slightly more and at no time, other than when you pull in the clutch lever, should there be any tension on the clutch pull rod. Any tension on the rod will cause premature clutch rod bearing failure and a broken clutch rod.