3.1.1 Belts

For our Norman supercharged grey motor, we have a number of choices of drive system. For example, we could use:

a) Direct drive off the crank snout. Direct drive has been used in a number of vehicles, including the Daimler-Benz race vehicles of the early 1900’s and many GM Roots superchargers in diesel service. Your typical early Holden however has very little room at the front of the crank to direct mount a supercharger. Whilst not impossible, direct driving a Norman supercharger is not readily practicable, nor very period correct.

b) A gear set. Gear driven superchargers are not that unusual, with Rolls Royce Merlin superchargers often being driven through single or two-speed gear drives. Gear drives are available from The Supercharger Store (see http://www.youtube.com/watch?feature=player_embedded&v=I0nizAm3bPw, which shows the ERA coupler fitted to one). Whilst not impossible, driving a Norman supercharger through gears is not readily practicable, nor very period correct.

c) A chain drive, as used on Stud Beasley’s Norman supercharged midget and Andrew Mustard’s supercharged Elfin (se anecdote below). We could fit a single, double or even triple row chain to the supercharger, and drive them from toothed sprockets on both crank and supercharger snout. This would provide a very positive drive, with no slippage. However, there will also be absolutely no slip should the supercharger stall (for example if the fuel/air mixture inside the supercharger and inlet manifold ignites during a blower bang). This means that during blower bang events the jarring energy can be transferred via the belt to the crankshaft. This can be like the unstoppable force meeting the immovable object, and lead to bending of either the supercharger drive shaft or the engine crankshaft. Unless we are chasing every last ounce of horsepower from our Norman supercharger (and are willing to wear the risks of damage), this type of drive is not recommended.

d) A gilmer belt. This is a toothed (positive drive) type of belt, again minimizing the risk of slippage. This type of drive is common on modern drag racing superchargers. Gilmer belts do pose similar risks to chains with respect to transmitting blower bangs. However, the Gilmer belt is more likely to shred/strip the belt teeth. Not such a big deal at the drag strip on a dedicated race car, though pretty frustrating in the Woolies carpark on a road-going car. Gilmer belts are also relatively wide compared to say a vee-belt. The real estate at the front of your typical Holden grey motor (between crank and radiator) is pretty small. Whilst not impossible, it can sometimes be a challenge to get a gilmer belt to fit. Gilmer belts are also relatively difficult to purchase… try finding one in your local SuperCheap. Again not really a problem if you carry a spare belt in the boot, but not too easy after stripping the belt in the middle of nowhere on a Sunday afternoon. Gilmer belts are period correct (and often seen) on the later (Mike) Norman superchargers, though not usually on the earlier (Eldred) Norman machines.

e) A vee-belt. Vee-belts are period correct, and provide some ability for the belt to slip during a blower bang. They are relatively cheap, and readily available from SuperChepa, Repco etc. For these reasons it is recommended that vee-belts be used on most Norman supercharged applications. Vee-belts are typically available in two profiles – normal/plain (see image below right) and ribbed/notched (see image above right). If a choice is available between normal and notched drive belts for Norman supercharger operation, then a normal belt should be chosen. The notched drive belt does have some benefits over the normal belt:

- They compress and grip better whilst still allowing good initial start-up slip (to avoid initially shocking the supercharger).
- The higher grip also allows them to compensate better for poor pulley surfaces.
- Less energy is required to bend the belt around the pulleys.

- They have a greater surface area for heat dissipation (i.e. they run cooler).

However, because the notched belts grip better, they are less likely to slip during a blower bang. The normal type belts however provide enough slip to prevent this occurring.

Note also that vee-belts are available in a ribbed format, as per the image to the right. Ribbed belts are very common in modern vehicles. They began to be used in Holdens around the VL Commodore era, and have all but replaced normal vee-belts. Ribbed belts are easier to flex around tight pulleys. However, they are not very period correct for a Norman supercharger.

Given the above, I will focus on normal vee-belts in the discussion below. There are a vast number of systems for designing the sizes of vee-pulleys and the associated vee-belts. These range from simple automotive belts, through to agricultural belts to general purpose belts. One of the challenges of finding an appropriate belt drive for the Norman supercharger is that we will often have to match up automotive pulleys with other types in order to get the correct diameter, bore or number of grooves. The discussion below will try to pull together what is available, and some alternatives.

As a starting point, we will look at the original Holden vee-belts (and pulleys) found on grey motors. These are automotive type pulleys, and are likely to have been made to the SAE standard *SAE J636 V-Belts and Pulleys*. SAE J636 specifies both metric and imperial belts. Metric belts are labeled in three parts:

- A number denoting the closest mm width of the belt (eg an “11” belt is roughly 11mm wide). This ranges from 6 to 23.
- The letter A, denoting automotive
- A number denoting the belt length (e.g. “990” for a belt that is 990mm long).

In the example above, the belt would be labeled 11A990, and the pulley referred to as an 11A.
Imperial belts and pulleys are labeled as decimals of the approximate pulley width. For example, a “0.250” pulley is 0.248” wide.

Most automotive aftermarket belts that are readily available in Australia (Bosch, Dayco) are metric automotive. Note that Holden grey motors use two different types of pulleys – a wide belt on the earlier Holdens (FX and FJ), and a narrow belt on the later (FE through EJ) grey motors. For FX and FJ Holdens, a type 15A belt is used, whilst the later FE through EJ Holden grey motors utilize the narrower 11A belts. For example for FX/FJ Holdens Bosch recommend a 15A1130 belt, whilst for later grey motors a 11A0955 belt whilst Dayco specify a 15A11300 and either a 11A0900 or 11A0950 respectively. Whilst your typical early Holden is running a metric belt, it is very likely that the original Holden pulleys were specified imperial (Australia didn’t start going metric until 1968, well into the red motor run, with industry making significant change in 1974, halfway to the blue motor in 1980). This means that the FX/FJ Holden wide pulleys (both water pump, alternator and crank) are likely to be $^{11}/_{16}$ (0.600) pulleys, whilst the narrower FE-EJ pulleys are likely to be 0.440 pulleys.

In short, our early Holden is running an imperial automotive vee-pulley, and probably a metric automotive belt. To keep things simple, it would be nice to be able to walk into Repco or Supercheap and use a similar metric automotive belt (or belts) on our Norman supercharger. Not only is it easy to find a Repco or Supercheap, but they are also likely to have a wide variety of belt lengths. This will make it easier to fine tune the belt length (rather than say ordering in a specialty belt from an industrial supplier, only to find it is slightly too long or short).

The question then becomes how many vee-belts we would need to drive our supercharger. From Supercharge!: “*Now as to how many belts are required to drive a particular supercharger. This depends on the type of supercharger, its size and the amount of boost intended. As a rough guide a standard* *car engine of 1500 c.c. using a seven pound supercharge and pulleys no smaller than 4 inches will require one 'A' section belt. A two litre with the same boost can manage with one 'B' section. A three litre will need two 'A' section. And a five litre V8 will need three 'B' section."*

Translating this to a 138ci (2260cc) grey motor, running 5-10psi of boost would infer a single "B" belt, or two "A" belts under heavy loading. This is very similar to the modeling presented below, which shows that a single modern 11A belt will probably handle most Normans, whilst a second belt is appropriate under heavy use.

A short note here on gilmer drive belts. As per the discussion above, a gilmer drive belt on a Norman supercharger is not ideal, but equally is not uncommon. The belts allow for zero slippage, and can break belts (or crankshafts or supercharger rotors) during a blower bang. Assuming that your new Norman has come with a gilmer drive pulley (and perhaps a belt), the question becomes what type of belt to put on the system (or what type of pulley to buy to suit the other one). The name "gilmer" is used somewhat loosely to describe a wide variety of belt profiles. The belt manufacturing industry refers to these belts as "timing belts", as they allow positive synchronization between two pulleys. The one thing these belts have in common is that they have teeth, which in turn mesh with teeth on the drive/driven pulleys. However, some caution needs to be taken before rolling into your local Repco store and asking for a gilmer belt.

The first difference in gilmer belts is the belt profile. Gilmer belt drives are typically either trapezoidal, curvilinear, or parabolic profile. The trapezoidal profile, available since the 1940's, is the easiest to identify. The trapezoidal pulleys and belts have flat peaks and roots, with sharp corners. The curvilinear and parabolic belts are harder to pick, as they come in a variety of configurations, including:

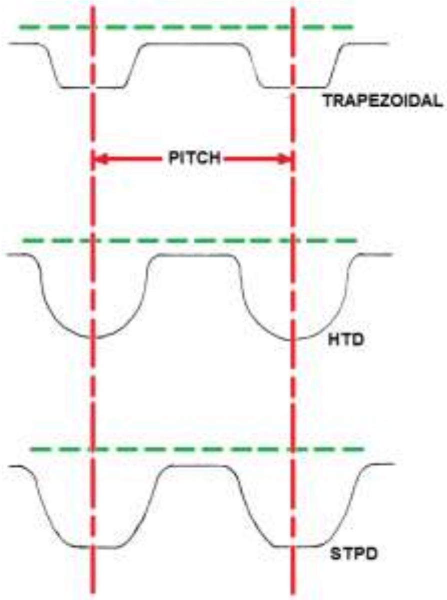
- High Torque Drive (HTD) – a curvilinear belt introduced by Gates in 1971. 
- Super Torque Positive Drive (STPD) – a modified curvilinear profile introduced by Goodyear in the early 1970's 
- GT – a modified curvilinear design developed by Gates in the late 1970's and often seen in US NHRA supercharger drives in current use. 
- Reinforced Parabolic Profile (RPP) – a parabolic profile introduced by Dayco (Carlisle) in the mid 1980's. 

Care needs to be taken in that whilst some of the above pulley systems are compatible with each other, some will only run their belt profile on their particular pulleys. If in doubt, it is wise to take the pulley (or belt) to a power transmission company (like CBC Bearings) for identification advice.

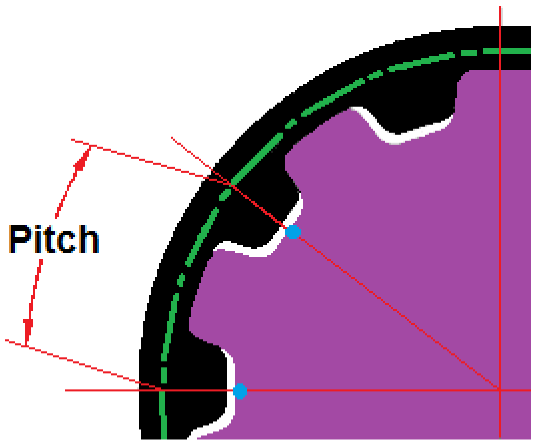
The next area in which there is quite some variation in gilmer belts is in the belt pitch. The various belt profiles have pitches as per the diagram and tables below.

Trapezoidal Profile	
Belt Cross Section	**Pitch**
Mini extra light (MXL)	0.080”
Extra light (XL)	0.200”
Light duty (L)	0.375” (3/8”)
Heavy duty (H)	0.500” (1/2”)
Extra heavy duty (XH)	0.875” (7/8”)
Double extra heavy duty (XXH)	1.25” (1 1/4”)

Curvilinear and Parabolic Profile	
Belt Cross Section	**Pitch**
3M	3mm
5M	5mm
8M	8mm
14M	14mm
20M	20mm



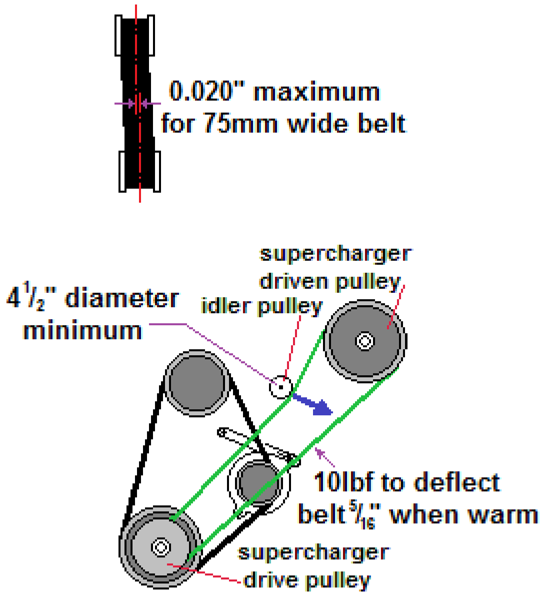
Note that the pitch distances shown above are measured on a belt, where the middle of the belt is shown by the green line (in the image above right). This is not quite as simple to measure on a pulley. The image to the right shows a purple pulley, running a black belt. The green line again shows the middle of the belt. When measuring the pitch of the pulley, it is measured at the middle of the belt. Measuring on the middle of the pulley teeth (where the blue dots are in the image) will give an incorrect pitch (too small).



The next area that gilmer belts vary in is the belt width. Thankfully, this is a lot easier to measure than pitch, by measuring across the pulley face. Finally, like vee-belts a gilmer belt will vary in length. Some suppliers specify the belt by the circumference (similar to a vee-belt), whilst other classify belt length by the number of teeth the belt has.

Whilst many of the rules for setting up gilmer pulleys is identical to that of vee-belts, some good guidance is given in *A study of supercharger belt failures, National Dragster July 24 1992*, and as shown by the purple arrows in the image to the right:

- Pulley alignment needs to ensure that pulley centers are no further than 0.020" misaligned on a 75mm drive belt.
- Back tension idler pulleys should be no less than 4½" diameter to reduce bending stress on the belt.
- Drive belts should be tensioned such that 10lbf is required to deflect the belt $^{5}/_{16}$" at mid-span on the drive portion of the belt (between the drive and driven pulley) on a warm engine.

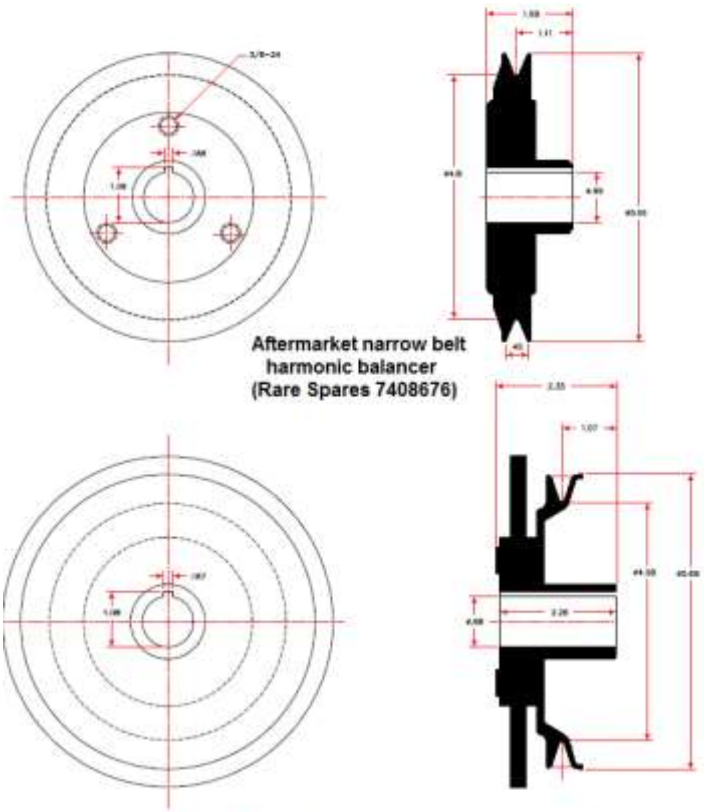


Whilst a number of sources are available for drive (and driven) pulleys, one local source is Naismith Engineering (http://www.naismith.com.au/pdf/timingpb.pdf).

3.1.2 Pulleys

For our Norman supercharger, we will be trying to connect the crank to the supercharger snout. This will involve a pulley on both shafts. It is possible to align the supercharger to the existing grey motor crank/water pump/generator pulley line, and use one belt to drive each of the fan, water pump, generator and Norman supercharger. However, for reasons which will be explored below this type of lienup is unusual and not recommended. Typically a dedicated supercharger belt will be required, and we will need to source both a supercharger drive pulley for the crank and a supercharger driven pulley for the supercharger snout. Bear in mind that we would ideally like to utilise the common (and cheap) 11A metric automotive belt profile.

For the supercharger drive pulley, a neat alternative is to bolt a flat pulley to the front of the grey motor harmonic balancer. The original GMH grey motor harmonic balancers have a flat face, though only the central hole (which is tapped to $1^{1}/_{8}$" UNF to accept the harmonic balancer puller tool). However, aftermarket grey motor harmonic balancers are available from PowerBond, and supplied by Rare Spares. These are Rare Spares part number 7401305 for the wide-belt FX/FJ (PowerBond part number HB17B-N) and 7408676 for the narrow-belt FE-EJ style (HB1049-N). Anecdotally (and just in case any of the red motor guys are reading this ☺), the respective EH-HZ red motor part numbers are M40284 and HB17A-N. Each of these aftermarket harmonic balancers has three concentric bolt holes, as shown in the images to the right. The holes are tapped through the hub to $^{3}/_{8}$-24UNF on a $2^{13}/_{16}$" (71.44mm) PCD. Whilst the holes are ostensibly there to mount a modern harmonic balancer puller tool, they also make a very neat mounting point to bolt up a flat pulley. The bolt-up pulleys from Holden red motors and Commodore Starfire 4-cylinder engines have this PCD, and are a neat bolt-on fit. However, a word of caution. The GMH red motor/Starfire twin-groove pulleys are not appropriate for the task. The GMH pulleys are two different groove sizes. For example, one groove is 5.25" diameter, the other 5.10" (or as another example 5.23" and 5.09"). Whilst this doesn't sound like much (and is hard to see by eye unless you are looking for it), the difference in groove diameter means that for our use as Norman supercharger twin-pulley drives they are not suitable. Connecting two different drive pulley groove diameters to the driven pulley (same groove diameter) puts the pulleys into bad conflict. One belt would slip badly. For example, on the 5.25"/5.10" pulley, at idle the belt would slip 8" every second, and at full noise 80". Way too much. I guess GMH only ever drove two different accessories (e.g. airconditioning and power steering) and never ran them as a twin belt.

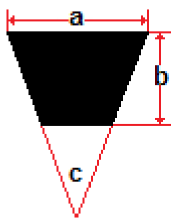


Early Holden wide belt harmonic balancer (FX/FJ, 7401305) and narrow belt harmonic balancer (FE-EJ, 7408676). Dimensions identical with the exception of pulley width.

An alternative is to find a flat pulley from another vehicle, drill three holes to the PCD above and bolt them on. One option is to use a twin-groove pulley from a Chev. These are readily available in aluminum (a Speedmaster PCE239.1008 item is not a bad choice (http://store.speedmaster79.com/)). These pulleys are 5.457" diameter, and can be mated up to a 6" driven pulley from Stenco to give the 1.1:1 typical drive ratio for a Norman Type 65 (or a 7" pulley to give 1.3:1). The downside to using Chev pulleys though is that the internal bore is much larger than the grey motor crankshaft (the Chev is $1^{1}/_{8}$" versus the 1" grey motor crank). This means it can be quite hard to centralise the Chev pulley onto the grey motor crank. I tried using one of the harmonic balancers as a template, and even taking quite some care could not get the three holes drilled perfectly concentrically. If using the Chev pulley it is recommended to either get a hub centric ring made up (a washer 1" ID and $1^{1}/_{8}$" OD), or to have the three mounting holes professionally drilled by a machine shop ($^{3}/_{8}$-24UNF on a $2^{13}/_{16}$" (71.44mm) PCD). Note when buying a Chev pulley that you will typically want one that lies very close to the harmonic balancer (rather than the "long water pump" type that stick out further).

Note that if you are sourcing pulleys (either drive or driven) from a wreck, almost all early Holdens (FE-WB, LC-UC Torana, VC-VK Commodore, VN-VS 308's) used the 11A metric/0.440 imperial pulleys. Be wary though that many of these models had the larger 13A metric/0.500 imperial pulleys on air conditioning. From VL Commodore onwards the six cylinder engines began to move towards the ribbed vee-belts.

For the supercharger driven pulley, it is not too likely that a pulley will be sourced from another vehicle at the wreckers, and will instead need to be sourced from the aftermarket. Aftermarket pulleys are often sourced from industrial, rather than automotive suppliers. This means we will probably be mix-and-matching an automotive drive pulley with an industrial driven pulley. Aftermarket industrial pulley profiles are often referred to in articles about Norman superchargers (for example in Supercharge! Eldred refers to his HR Holden Type 110 supercharger being driven two 'A' section belts, and his Australian Grand Prix Triumph TR2 G.M. 271 supercharger being driven by four). A common specification for industrial (often referred to as "classical") pulleys is *ISO 4183:1995 Belt drives -- Classical and narrow V-belts - Grooved pulleys (system based on datum width).* This aligns well with the standards used by the Mechanical Power Transmission Association (MPTA), a North American association which drives vee-belt standardization. Classical pulleys are labeled by a letter (A, B, C, D) in increasing order of width. Note that there are standard classical pulleys, and deep groove pulleys, which have different dimensions. The table below shows the various automotive and classical pulley dimensions:



Belt profile	**Metric Automotive**					**Conventional**			
	11A	**13A**	**15A**	**17A**	**20A**	**M**	**A**	**B**	**C**
Width (a)	10.7mm	13.3mm	17.3mm	18.8mm	22.8mm	$^{3}/_{8}$" (9.5mm)	½" (12.7mm)	$^{21}/_{32}$" (16.7mm)	$^{7}/_{8}$" (22.2mm)
Height (b)	8mm	9mm	11mm	11mm	13mm	¼" (6.4mm)	$^{5}/_{16}$" (7.9mm)	$^{13}/_{32}$" (10.3mm)	$^{17}/_{32}$" (13.5mm)
Angle (c)	38º					40º			

The table below shows the dimensions for the various automotive and classical pulley sizes of the same rough size as an early Holden in order of pulley (and hence belt) width (perhaps a little easier to sue than the table above):

Pulley	**Width (mm)**	**Depth (mm)**	**Angle (º)**
0.250 (imperial automotive)	6.3	7	36
0.315 (imperial automotive)	8.0	9	36
0.380 (imperial automotive) and 10A (metric automotive)	9.7	11	36
0.440 (imperial automotive) and 11A (metric automotive)	11.2	13	36
A (standard classical)	12.5-12.8	12.4	34-38
0.500 (imperial automotive) and 13A (metric automotive)	12.7	14	36

$^{11}/_{16}$ (a.k.a. 0.600) (imperial automotive) and 15A (metric automotive)	15.2	14	34-38
A (deep groove classical)	15-15.5	16.4	34-38
B (standard classical)	16.2-16.5	14.7	34-38
17A (metric automotive)	16.8	15	34-38
¾ (a.k.a. 0.660) (imperial automotive)	16.8	16	34-38
B (deep groove classical)	19-19.7	19.3	34-38
C (standard classical)	22.3-22.7	19.8	34-38

From the table, we can see that if we want to mix and match automotive and classical pulleys:

- an A standard classical pulley will be closest to the original 0.440 narrow grey motor pulleys used on FE-EJ Holdens, whilst
- an A deep-groove classical pulley will be closest to the 0.600 wide grey motor pulleys used on the earlier FX/FJ Holdens.

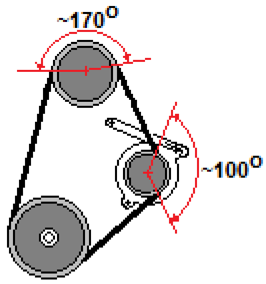
Given that we would ideally like to utilise the common (and cheap) 11A metric automotive belt profile, this means we are hunting for an A classical pulley.

Aftermarket die-cast aluminum pulleys are available from Stenco, an Australian manufacturer based in NSW: http://www.stenco.com.au/images/STENCO-Brochure.pdf. Stenco make both tapered bore and straight bore pulleys. The Norman supercharger shafts are straight bore, with the bore diameter around the varying between .868-1"" and with a variety of keyways. When using Stenco pulleys it is likely that the pulley bore (and potentially also the keyway) will need to be bored/recut to suit the Norman supercharger. As an example, the pulley on Gary's Type 65 Norman is a Stenco 5" 2A unit. The 2A reflects a double pulley and A-profile. I suspect that this is a part number 2A0503 whose 1" bore and $^{3}/_{16}$" keyway were machined back to 0.890" and ¼" respectively. Note that Stenco are quite capable of producing one-off pulleys to given bore/keyway dimensions. Be wary however in measuring a Norman supercharger in that they are a delightful mixture of imperial and metric sizes – as an example, the Type 45 supercharger pulley has a 30mm bore and a $^{3}/_{16}$" keyway.

Note that for those wishing to drag race their Norman blown vehicles under the Australian National Drag Racing Association (ANDRA) rules, the ANDRA Rulebook General Regulations indicate that cast supercharger pulleys are prohibited in ALL classes. This would negate the ability to use STENCO pulleys. The Regulations also indicate that all vehicles equipped with belt driven superchargers must be fitted with a guard to prevent fuel line damage in the event of belt loss, except in cases where braided lines are used. As an aside, the typical Confederation of Australian Motor Sport (CAMS) grey motor road racing classes (Na for Touring Cars pre-1958 and Nb for Production Touring Cars per-1965) do not allow supercharging as it was not an original GMH option… vehicle wishing to compete in CAMS events with a Norman blown grey would need to compete in Regularity events where there are not supercharger prescriptions.

In order to drive the belt, the vee-pulley must have sufficient friction with the drive belt. Vee-belts do not actually bottom-out in the grooves, but instead transmit their driving force through the side walls of the vee groove. As load increases, the belts smoosh further into the groove, increasing the contact area and hence grip. The amount of grip that we can generate with a vee-belt is proportional to the square root of the belt/pulley contact area – doubling the contact area gives 40% more grip. There are two number of ways we can increase contact area:

a) By using larger pulleys. The relative sizes of the pulleys (drive and driven) is largely determined by amount of boost required, which we have calculated below. In practical terms for our Norman supercharged grey motor, it is likely that there will be limitations on the availability of the crank pulley. This will probably then lead to using whatever crank pulley is available, then tuning the supercharger driven pulley. If we have a choice, we should aim for larger pulleys. As well as increasing contact area, the larger pulley diameters tend to flex the belt through less of an angle. This dramatically reduces belt loading and increases belt life. As a rough guide (and as noted in *Supercharge!*), we should be aiming for pulleys no smaller than 4" in diameter. As a comparison, the standard grey motor harmonic balancer has a $4^5/_8$" diameter, an approximately 1" bore and a $^3/_{16}$" keyway.

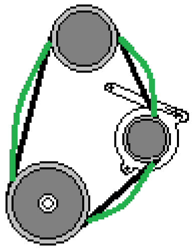


b) By increasing belt wrap. Belt wrap is the amount (or angle) that the belt is in contact with the supercharger pulleys, measured through the pulley centerline – see image to the right. The higher the belt wrap, the more contact area and better grip. Often we have little choice about where the crankshaft and supercharger pulleys are relative to each other – manifolding becomes the constraint. This means there is not much room to move the supercharger around to increase belt wrap. However, we can sometimes use an idler or tensioner pulley to increase belt wrap, as we will see below.

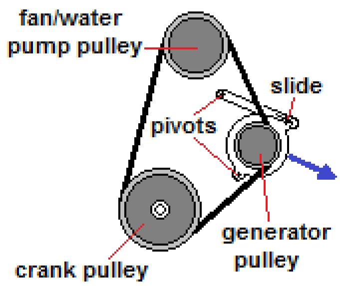
Whilst steel is far stronger than aluminum for supercharger pulleys, we are often likely to be limited to what is available in the market place. Chromed-steel pulleys should be avoided where possible due to the very slippery chrome surface promoting belt slip. Where aluminum pulleys are used, consideration should be made to having the groove faces hard anodized to reduce wear. Plastic is generally not suitable for supercharger pulleys, though is sometimes used for idler pulleys, and will be discussed below.

3.1.3 Belt Tensioners

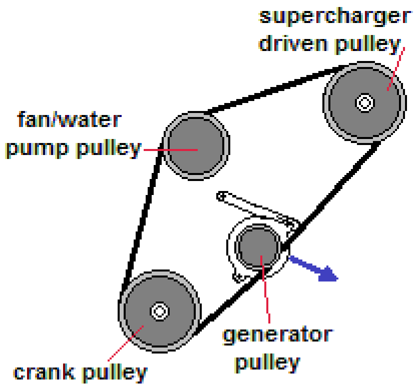
As the supercharger drive belt is loaded, there is a strong tendency for the belt to move into a more circular shape. This phenomena is called orbiting, and can be seen by the green belt shown in the image to the right. Orbiting reduces belt wrap, which in turn reduces the grip that the belt has on the pulley, leading to slippage. To reduce orbiting we can put the belt under tension in a number of ways.



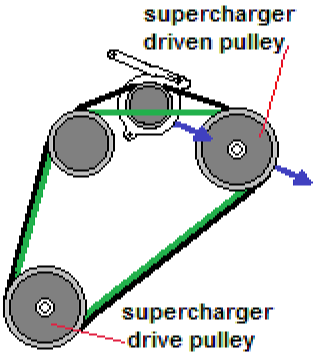
In the standard Holden grey motor lineup, the engine belt is crank driven, and drives both the engine fan/water pump, and the generator. This lineup is shown in the image to the right. Whilst the crank pulley and fan/water pump pulley are fixed to the engine, the generator is able to pivot about two points. By moving the generator in the direction of the blue arrow, additional tension is placed on the belt. The factory specification for belt tensioning indicates there should be $^3/_8$" of slack between the fan/water pump pulley and the generator pulley. I will refer to this type of drive system (where one of the driven pulleys and attached equipment swings) as "swinging" in the text below.



A similar swinging drive system can be used to provide tension to the supercharger belt. If the same drive belt is used to drive each of the engine fan/water pump, the generator and the supercharger then the tension can be applied by swinging the generator. A swinging system of this type is shown in the image to the right. This type of system however tends to have very low belt wrap, significantly increasing the amount of tension required to achieve a non-slip drive. Additionally, the belt is now driving a fan, a water pump, a generator and a supercharger. This is a significant amount of load for one belt to carry. For these reasons, this type of drive system is not recommended.

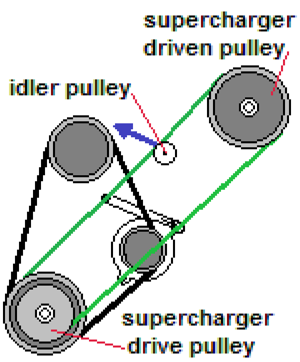


A different swinging drive system can be achieved if a dedicated supercharger drive belt is utilized. In this case the tension can be applied by swinging the supercharger. This type of drive system can achieve good belt wrap, lowering the amount of tension required to achieve a non-slip drive. Given the belt is dedicated to driving the supercharger, the loading is lessened (and either fewer belts can be used, the belt profile reduced or the belt life extended). However, swinging the supercharger is not without it’s down sides. The carburetor must also swing with the supercharger, which can provide some unique float bowl angles and hence additional work to attain a satisfactory fuel level. Further, the manifolding between the supercharger and the engine’s cylinder head must have sufficient flexibility to allow the supercharger to move. This can be achieved by the use of pipe, either rubber/silicon or convoluted metal. A drive system of this type is shown in the figure above, and also in the photograph above of the supercharger removed from the Bobcat custom humpy, and subsequently fitted to Anthony Harradine’s EJ Holden Premier. This system has a triple-groove pulley fitted to each of the crank, fan/water pump and supercharger. Two of the three grooves on these items are belted together, giving the green drive line shown in the image above. The third pulley groove on each of the crank, fan/water pump and supercharger is also run to the generator, which has a single-groove pulley. Both the generator and supercharger can be independently pivoted, providing belt tension as per the blue arrows above.

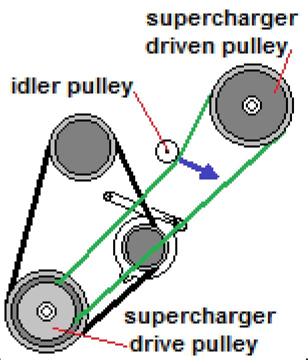


An alternative to a “swinging” drive system is to apply an idler (also known as a jockey or tensioner) pulley to the system. In this case the driven pulleys are all fixed, and the idler pulley moves to provide belt tension to the supercharger.

The “idler” drive system shown to the right has a dedicated supercharger drive belt(s), shown in green. The idler pulley is placed inboard of the belt. By moving the idler pulley in the direction of the blue arrow, additional tension is placed on the belt. In this case the idler pulley runs on the vee-side of the belt, and must have a vee-pulley face. Systems of this type reduce belt wrap, increasing the amount of tension required to achieve a non-slip drive. The drive system on Gary’s Type 65, shown in the image above, has an inboard idler drive system.

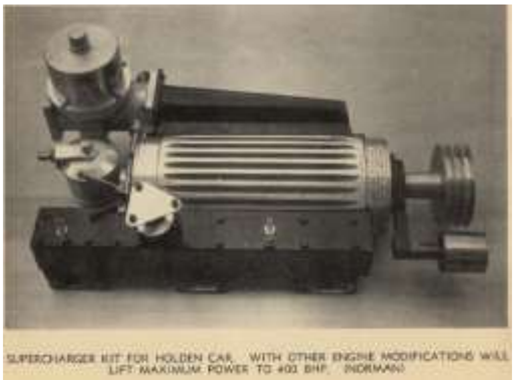


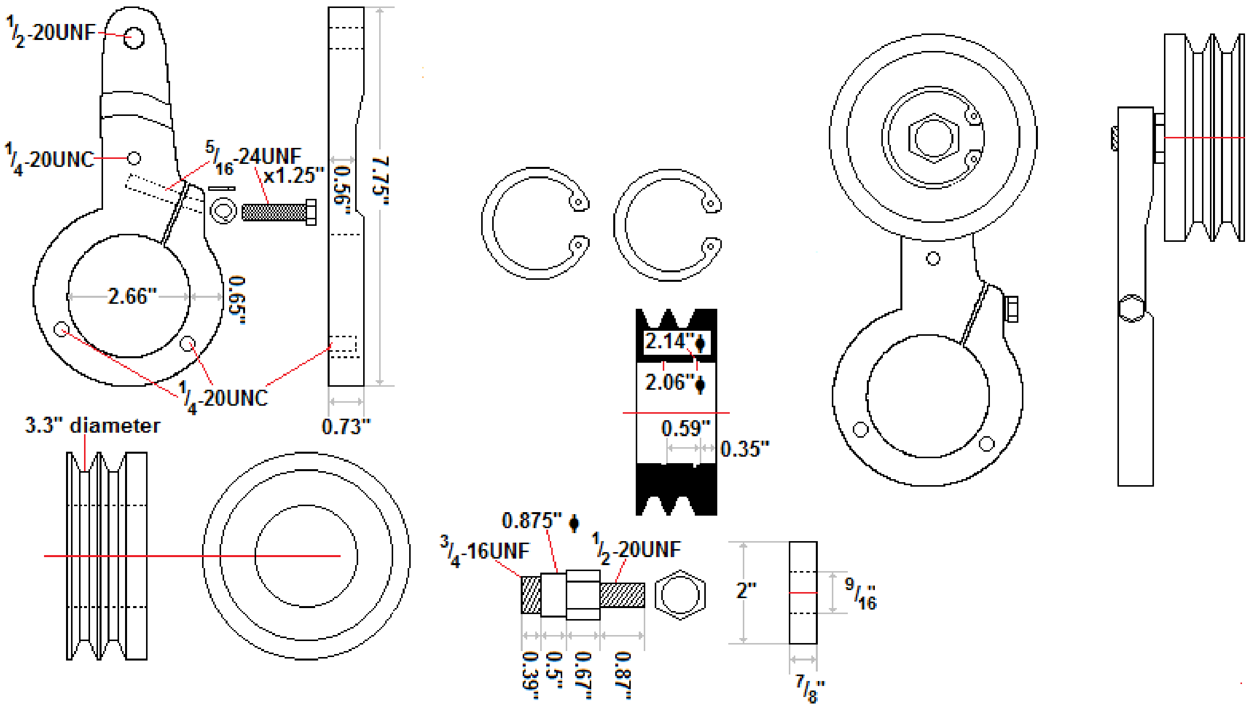
The idler drive system shown to the right again has a dedicated supercharger drive belt(s), though in this case the idler is placed outboard of the belt. By moving the idler pulley in the direction of the blue arrow, additional tension is placed on the belt. In this case the idler pulley runs on the back of the belt, and must have a smooth pulley face. Systems of this type increase belt wrap, lowering the amount of tension required to achieve a non-slip drive. This system is preferable to the one shown above. Note however that in this case the belt is being flexed additionally compared to the system above, which can reduce belt life. The Norman superchargers shown in the images below utilize this type of drive system.

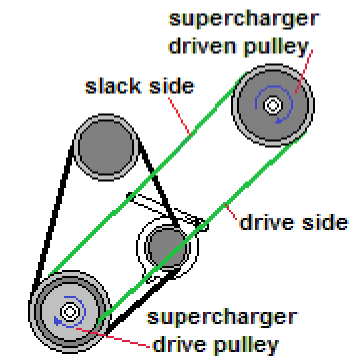


Whilst the supercharger and crank pulley locations are often relatively fixed, there is generally more leeway to move around the idler pulley location. To mount an idler pulley, a number of options are available. These include:

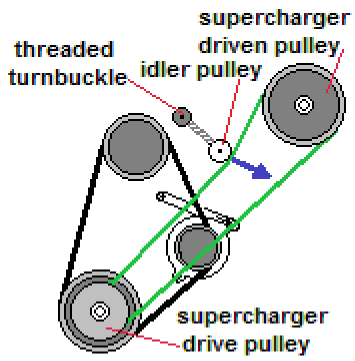
a) Using a lever-type bracket directly back to the engine block (similar to the photograph of Cliff Kiss' FED above,
b) Marking an engine plate-type bracket and mounting the idler spindle in a slot, similar to the image below right,
c) Making a clamp-type bracket that clamps around the supercharger snout. This type of mounting is very typical of Norman superchargers, and can be seen in several of the images above. The image below shows the typical dimensions for a Type 65 clamp-type idler.





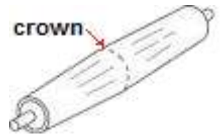


In terms of location, note that supercharger drive belts have a slack side and a drive side. Like a piece of rope, the crank can pull on a belt but cannot push on it. With the crank rotation as per the blue arrows in the image to the right, the slack side is on the driver's side of the vehicle, and the drive side of the belt on the passenger's side. Where a choice is available, the idler should be installed on the slack side of the belt. This reduces loading on both the belt and the idler. The idler pulley should be located at least twice the idler pulley diameter away from the nearest other pulley. This gives the belt a chance to relax after it's last bending, get aligned if the pulleys are not dead-true and also to pass through some air and cool down, each of which will extend belt life.



Regardless of whether a swinging or idler system is used is, the belts are under considerable duress during service. Stops, starts, acceleration and deceleration, the odd blower bang and constant vibration all add up to gradually slacken the belt tensioning. There is a trick that can both assist in maintaining tension, and also in getting the right tension in the first place. This is to utilize a turnbuckle (or similar threaded connector) to push against the idler pulley. The turnbuckle is mounted to the engine block, preventing the supercharger, generator or idler pulley from slipping back out of tension. By twisting the turnbuckle it is also then easy to tighten the belt without using long bars to swing the supercharger, generator or idler pulley.

Plastic is generally not suitable for supercharger pulleys, though is sometimes used for idler pulleys. As a general guide, plastic is suitable to be used provided the idler is employed on the slack side of the drive loop (not the drive side), and when the belt wrap is at most 90º. Idlers operating on the drive side of the belt or with more than 90º of belt wrap should be made from either aluminum or steel. Some idler pulleys have a shoulder (or flange), such as the Kilkenny Castings KC160 pulley shown to the right. The flange can help keep the belt aligned, and whilst no replacement for good setup alignment can help with minor belt misalignment. Some flat pulleys are also cronwed, where the surface is gently curved at the top. In theory this can help centre the belt (provided the initial alignment is perfect), as can be seen in the video here: http://www.youtube.com/watch?feature=player_embedded&v=6sM0Qjumyro. However, practical terms for a home-built system is probably neither a hindrance nor help.



Idler pulleys are available from SuperCheap Auto as per the table below:

Part Number	Manufacturer	Pulley Diameter (mm)	Width (mm)	Bearing Bore (mm)	Pulley Material	Flanged ?
38015	Gates DriveAlign	76	25	17	Plastic	No
38006	Gates DriveAlign	76	30.5	17	Steel	No
38005	Gates DriveAlign	82	30.5	17	Steel	No
38001	Gates DriveAlign	90	30.5	17	Steel	No
KC160	Kilkenny Castings	82	30	17	Chrome plated steel	Yes

A single 11A vee-belt has a width of 11.2mm, and would run readily on any of above pulleys. A twin 11A pulley has an effective belt width around 25mm, which would rule out the use of the Gates TrueAlign 38015. The pulley that stands out though is the Kilkenny Castings KC160, pictured above. It has a width suitable to run either single or (most) twin vee-belts. The chromed steel look is also period correct. The pulley runs a SKF 6203-2RSH bearing, which is rated to 12,000rpm. The pulley internal bore is 17mm, suitable for an M17 bolt to be used as a shaft. M17 bolts are somewhat unusual, but have a shank diameter around 16.974mm. A alternative is to use a ¾” bolt (19.05mm) and turn the shank down to just under 17mm. The bearings on the KC160 can also be replaced with a 40mm OD/19.05mm ID bearing (bearing part number 6203-¾). These are an oddball bearing, with a metric OD and ¾” imperial ID. This would allow you to use a ¾” high-tensile bolt as the pulley spindle without machining. The photographs below show the KC160 in use on a Type 65 Norman:

Note in the image above right that a turnbuckle has been used. The stainless steel turnbuckle (from Bunnings) has an eye at either end. With a little judicious bending, the turnbuckle bolts between the thermostat housing bolt and the ¼”-20UNC hole tapped into the idler arm (see drawing above). This is a very neat way to put tension on the idler, and stop it vibrating loose over time. It also means you can tighten the belts easily without trying to hold tension on the idler pulley with a long bar. I have also maximized the belt length in the above installation such that only about a fingers breadth exists between the two belts (see image to the right). Doing this increases belt wrap – in the configuration above I achieved some 230º of wrap on the driven pulley, 155º on the drive pulley and 80º on the idler. These are pretty damn good values, with no need to tighten the absolute crap out of the belts to prevent slippage. Note that it is possible to use a shorter belt, with the idler moving more towards the drivers side of the engine with less slack to take out of the belt.

One issue that needs to be checked is the speed that the idler pulley operates at. The large diameter of the crank and supercharger pulleys will generally mean that bearings will tolerate the speeds involved. The smaller idler pulley however can often spin much faster. The pulley speed is proportional to the diameter of the idler pulley i.e.:

$$idler\ pulley\ speed = crank\ pulley\ speed\ x\ \frac{crank\ pulley\ diameter}{idler\ pulley\ diameter}$$

As an example, the Gates DriveAlign pulleys noted above have a nominal speed limit of 8,000rpm. If we assume the crankshaft pulley is approximately the same diameter as the grey motor harmonic balancer ($4^5/_8$", or 117mm), and that we are running at a grey motor typical rpm redline of 4500rpm, then

$$8{,}000 = 4500\ x\ \frac{117}{idler\ pulley\ diameter}$$

, and we see we can go down to an idler pulley as small as 66mm diameter without any speed concerns (i.e. each of the above pulleys would be OK). Checking the Kilkenny Castings KC160,

$$idler\ pulley\ speed = 4500\ x\ \frac{117}{82} = 6420\text{rpm}$$

This is well below the 12,000rpm pulley speed limit, again making the Kilkenny Castings KC160 an ideal candidate. As an aside, the 6203-¾ bearing that can be used in the KC160 typically has a similar speed rating – the one I used in the images shown above was rated to some 10,000rpm.