Heavy Duty Axles

Instead of a restoration up date, a bit of a technical article instead. As I mentioned in the past, the hubs on my 1936 Aero 600 were a bit of a sorry state. So I decided it would be just as well to turn new ones up. While I was at it I thought I might do something about the chronic problem the Dougies have with bent axles. Or at least my Dougies seem to chronically have, but I do recall others mentioning the same problem in the NCR. Sure one could just make exact copies out of modern materials, but if Douglas were making their axles from the same 4% nickel steel they stamped the o.h.v. crankshafts from, well only a meager improvement could be gained. So I thought a redesign as well as modern steel would best cure the problem.

On the drawing of the hub, I have shown the original configuration for those that wish to use the drawing for that purpose. Really the modifications to the hub are slight to incorporate an improved axle and sealed ball bearings, which is shown in the auxiliary view. Primarily this is the reduced O.D. of the ball bearing verses the taper roller type. Important is the closer tolerance required on the shoulder to shoulder distance that the bearings abut. An original hub can be modified to ball bearings by inserting thin wall sleeves. In this case the shoulder to shoulder distance of the axle will have to be machined to suit the exact dimension taken from the existing hub. The important thing is to maintain a zero to three thousands positive clearance on assembly. Unlike the taper rollers which you adjust post-assembly, with the ball bearings the end float is set by the tolerance when machining the parts. Getting it right to start will avoid having to shim it to the proper clearance, as done on post war machines. The ball bearing modification does not interfere with fitting a speedometer drive gear, but a special bearing nut will be required, since these are larger than original.

It is important to note if making a whole new hub, the spoke holes in each flange are not directly opposite each other, but are ‘phased’ 9°. The distance between two holes is 18°, so the ones on the opposite flange split the difference. This is so on any hub using 40 spokes.

For all those home-machinists out there, you may wonder how to get both bearing bores perfectly aligned, since they will have to be bored from both ends as separate operations. A suggestion: rough out the O.D. profile, but leave two turned cylindrical diameters where the spoke flanges will be. It does not matter what the diameters end up or if they even match, as long as they were turned in the same set up so they are concentric. As you set up to bore each end, use the turned diameters to indicate the part true. No matter which way the part is facing, if both diameters indicate with no run out (simultaneously), then the hub is rotating perfectly about a common axis.

It is very important to get both bearing bores in perfect alignment, or else the bearings will have a very hard (and shortened) life. This is why the originals taper rollers get so bad, but there it is the axle bending that get things out of alignment.

That is all I have to say about the hubs, as in truth it is unlikely few will go to the bother of turning new ones. If you think you will have a go, write for more details.

Moving on to the axles, this is where the major improvement lies. Note the larger diameter between the bearings. This is where the original axles are most deficient. Making new axles with fat centers for the taper roller bearings is little improvement because they still have to neck down to Ø1/2 or Ø 7/16 for the bearing, and will instead just bend there, if so inclined. The ball bearing used has a larger I.D. The ball bearing is a MRC 103KSZZ, Ø17mm x Ø35mm x

10mm with a synthetic seal on both sides. This bearing is listed as an extra light series. I picked it because I felt the larger axle diameter permitted through the bearing was a definite advantage. In case anyone is concerned that it may seem too light for the job, consider that it is rated at 470 lbs at 1000 rpm, each. This equates to about 1880 lb (including rider) at a maintained 77 mph. Since a stock Aero can manage about 62mph terminal velocity and weighs but 317lbs, that leaves slightly over three quarters of a ton for rider, passenger, camping gear, and portable tea making kit. Other equivalent sealed, radial bearings are: FAG 6003.2RSR, Fafnir 9103PP, and SKF 6003 2RS1.

The above bearings should have no trouble with the modest axial loads that will be encountered. There are also some angular contact bearings in the same sizes, but I could not find any that were sealed. This means separate seals would have to be incorporated into the design, and it really is not worth the trouble. All the motorcycle hubs which were ball bearings that I have seen so far were just standard radial types. (Angular contact, no seal: FAG B7003C.TPA.P4.UL; MRC 7103-KR, axial thrust 560lbs each @1000rpm)

The axles are still Ø1/2 or Ø 7/16 respectively outboard of the bearings. Otherwise permanent modifications would be required to the frame and backing plates, and that would not do. By far, the most important thing is to keep the bearings aligned. If the axles were to bend outboard of that, though it would be undesirable, will not destroy the bearings.

I have drawn up general arrangements of the new and old hub assemblies. Neither is dimensioned, as they are just for reference. If anyone is making copies of the old axles (why?) dimensioned drawings are included.

I retained the original threads for the axle nuts, but made the bearing nuts an American standard for my convenience; you can substitute with your preference. I never could fathom why Douglas used a L.H. axle nut on both ends. I paired right and left-hand threads for the bearing nuts, but left the axle nuts all left-hand as original. So if the wheel bearing seize, it will still try and undo the nut on the off-side. But the bearing nuts will not come loose!

The material for the axles is SAE 4130, chromium molybdenum steel. EN16 is a close British equivalent. I assume everyone has heard the dire warnings not to use something too weak (mild steel) or something too hard (silver steel) for critical components such as axles. Go out and get the proper material. Fortunately there are suppliers that will sell this material by the foot in the USA, two I know of offhand, that I deal with.

Heat treat condition ‘N’ (or Normalized, not to be confused with annealed) is common for SAE 4130 as supplied, I do not know what the equivalent for EN16 might be, but it leaves 4130 with an Ultimate Tensile Strength of 90,000 PSI. So something similar will do. Much higher UTS, well over 100,000 PSI is possible with 4130, but unwarranted. Besides it can be purchased already at condition ‘N’, and still be machined with conventional tools. In fact it machines much worse if annealed, being a bit ‘gummy’.

The two grooves adjacent to the bearing shoulders are optional but recommended. Their function is to transfer the stress concentration of the sharp internal corner required by the bearing shoulder, inboard, to the more generous radius of the grooves. The shoulders become just that, shoulders, and are largely bypassed by the bending loads and stresses of the axle. Not entirely, alas, but it helps, as the race car boys have discovered.

The bearing nuts are a little more complicated than they appear. Construction wise, I think it is easier to thread the I.D. clear through and silver solder in the insert. Otherwise one would have to cut a blind thread, and that is more difficult. It is important to have the end faces square to the thread, so that it seats properly against the bearings. This is easy enough if it is threaded and faced in the same setup in the lathe. After the insert is silver soldered in, the nut can be screwed on to a threaded mandrel so the face of the insert can be squared off to the proper length in the lathe. The part should be left a tad long for this purpose. The length of the bearing nut and the ball bearing equal the cumulative length of the original taper roller bearing assembly and nut. Unlike the original, there is no variation due adjustments.

Externally the nuts come in three variants. There is the 'basic' nut used behind the brake backing plate. The next one has a 'fake' hex milled on it to represent the hex pressed in the tin dust cover. There is a slight register turned between the two hexes to braze on a dust cover, which in this case only needs a corresponding round hole in it to suit. An old dust cover with a shredded hex can be salvaged for this use. If a Douglas speedometer gear drive is fitted, the corresponding nut will have to be reduced in diameter slightly as shown for additional clearance.

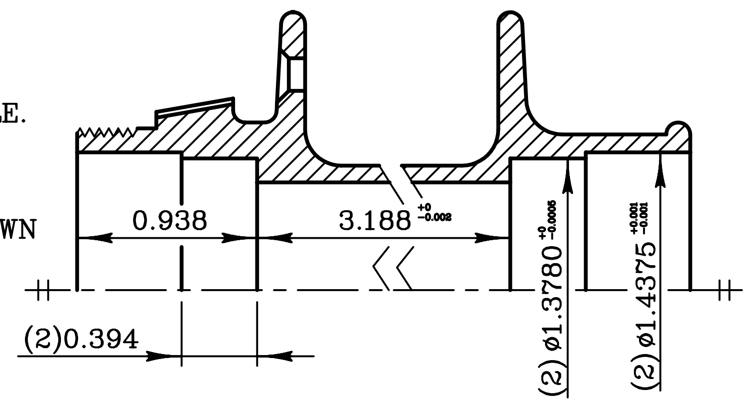
The whole purpose of the insert to make a blind thread is to increase the surface area on the face of the nuts; it is a bit minimal on the original design. If one forsoke the 'original' appearance and eliminated the 'fake' hex on the dust cover, this could be achieved on all the bearing nuts.

Well that is about all I can add, the drawings should explain the rest, I hope!

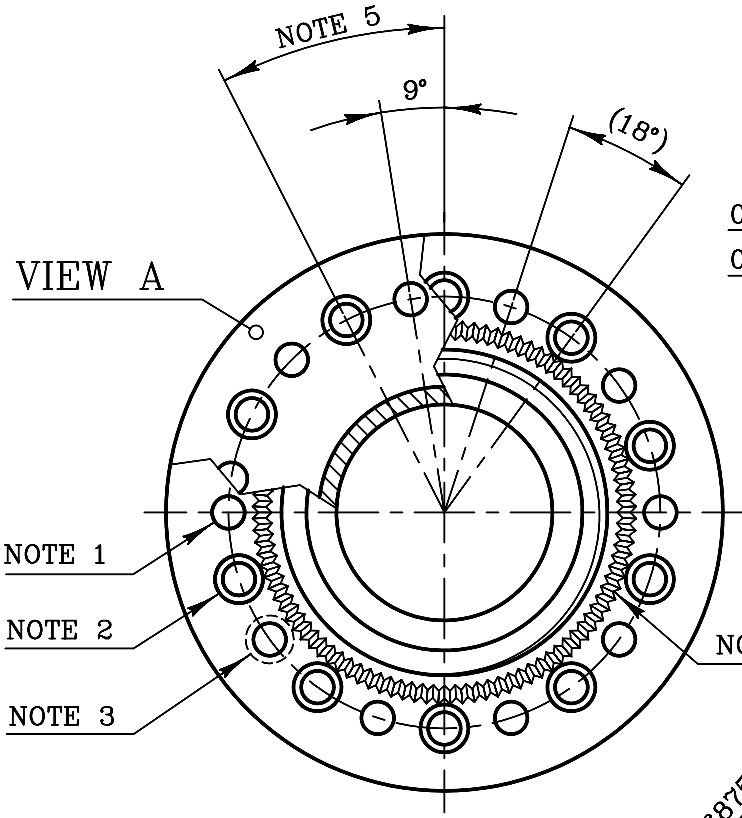
First published Jul/Aug 1995 New ConRod
A magazine of the London Douglas Motor Cycle Club
Revised and updated 01Aug06

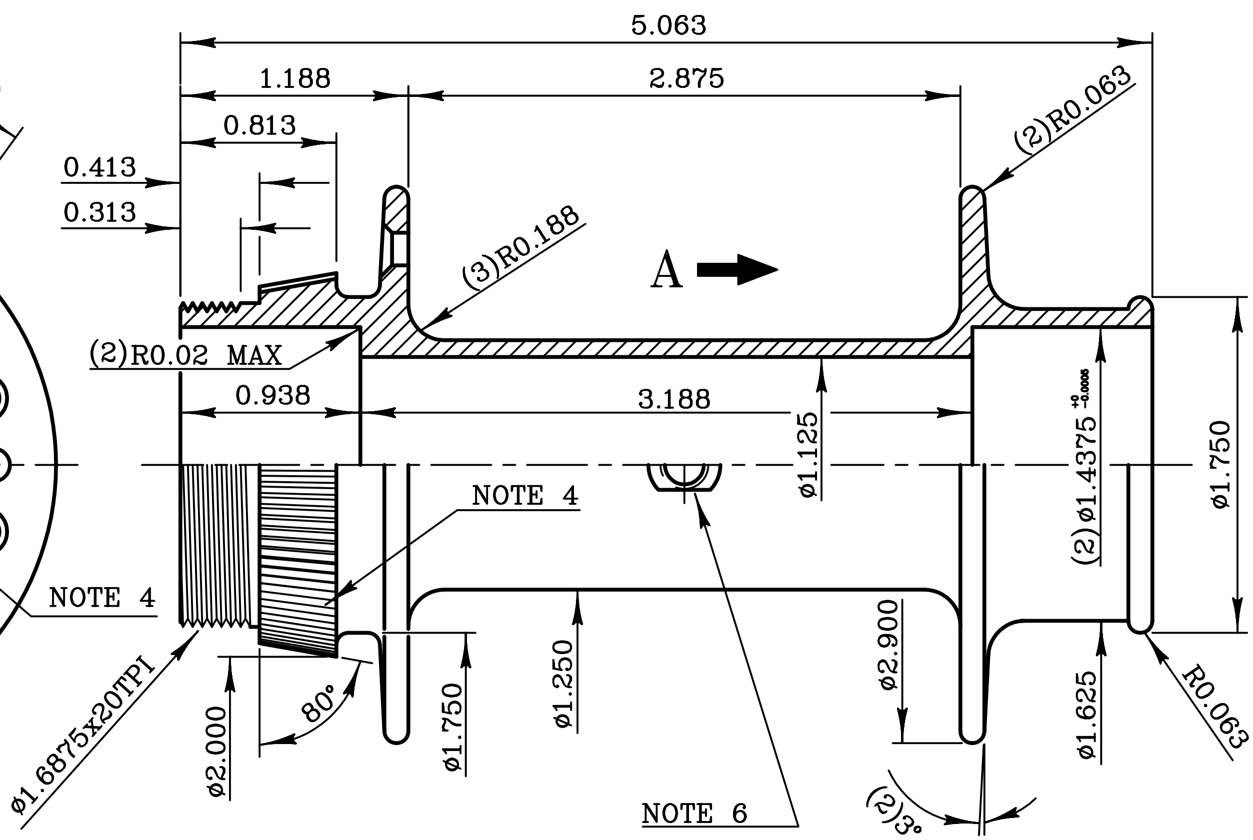
NOTES:

1. 20 ø0.172 HOLES EACH FLANGE, EQUALLY SPACED ON ø2.250 PITCH CIRCLE.
2. COUNTERSINK 40 PLACES, ø0.250 x 90°.
3. COUNTERSINK EVERY OTHER HOLE ON REVERSE SIDE OF FLANGE.
4. 100 SERRATIONS WITH 90° DOUBLE ANGLE CUTTER.
5. ORIENTATION OF COUNTERSINKS BETWEEN EACH FLANGE MUST BE AS SHOWN TO ALLOW CORRECT LACING OF WHEEL.
6. DRILL & TAP 1/4–26BSF, LIGHTLY SPOTFACE ø3/8 FOR GREASE FITTING.
7. MATERIAL: LOW CARBON STEEL.



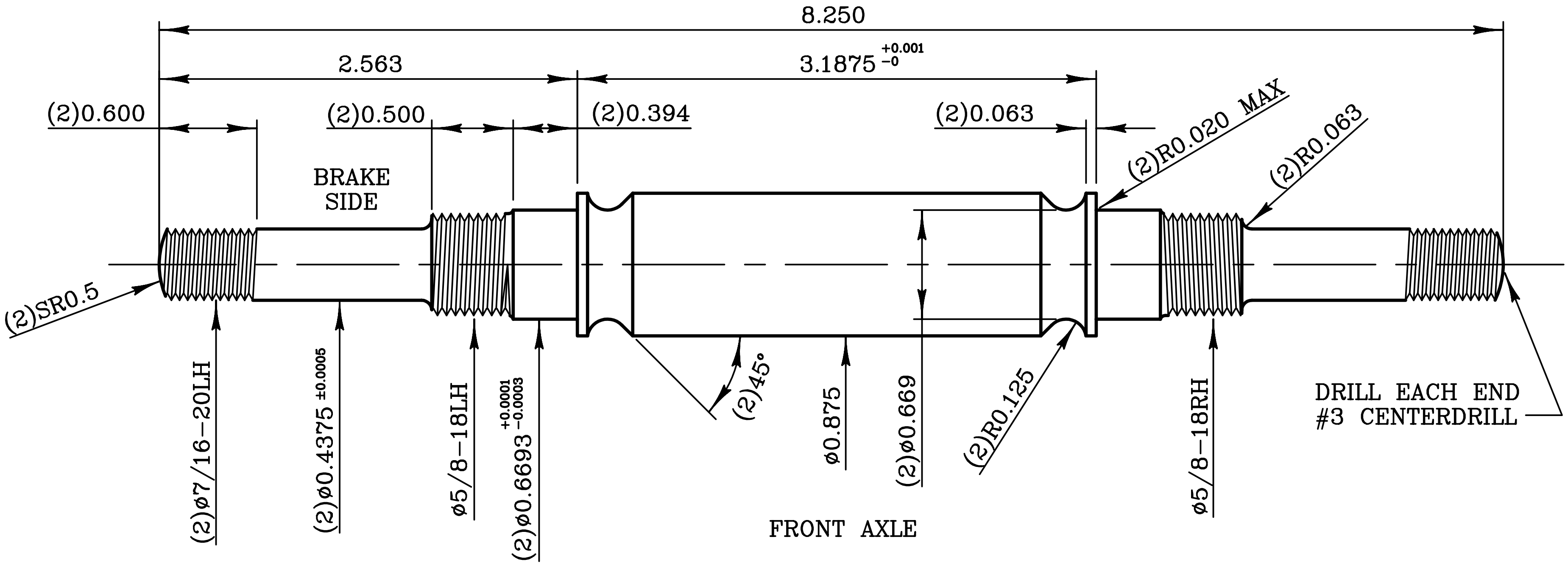
ALTERNATE DIMENSIONS FOR BALL BEARINGS



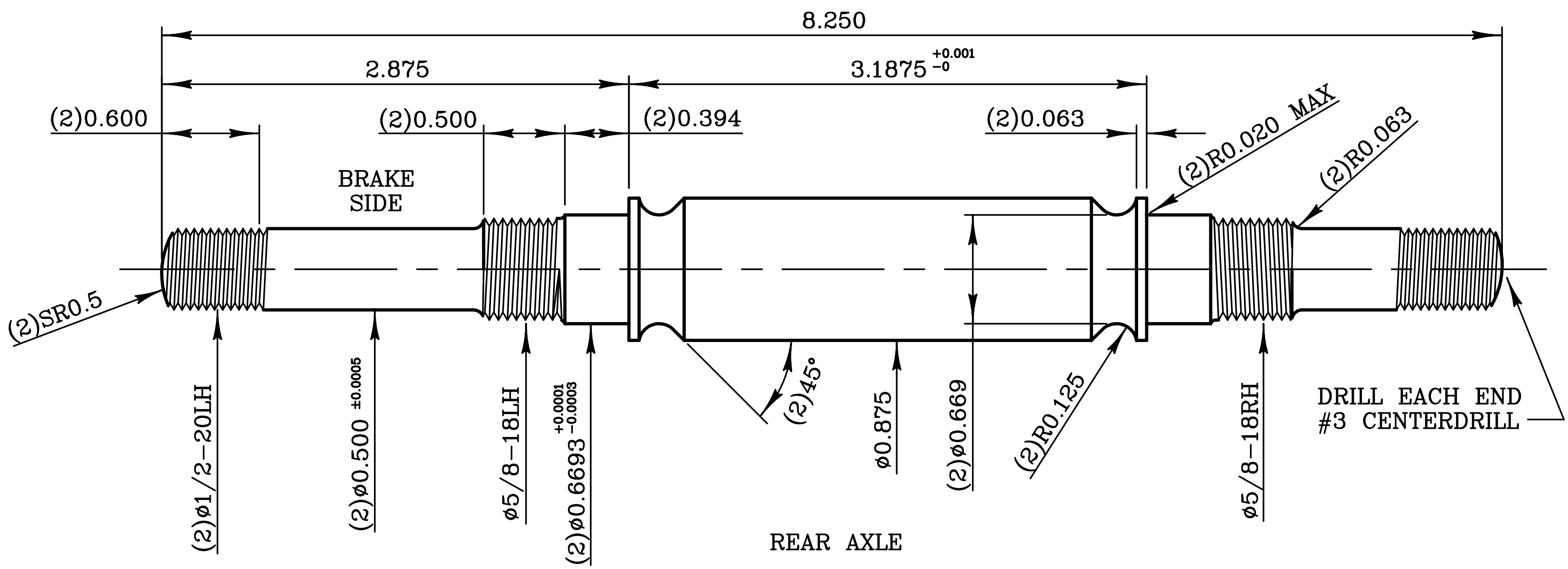


3/3/95

DOUGLAS KEPHART, GLEN MILLS, PA. U.S.A.



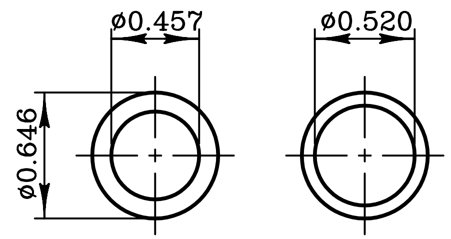
FRONT AXLE



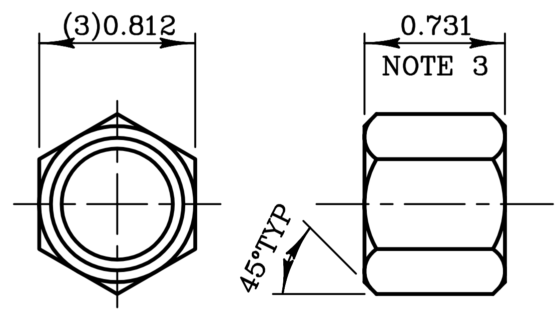
REAR AXLE

NOTES:
1. TOLERANCE UNLESS SPECIFIED, ±0.005
2. MATERIAL: EN16, SAE 4130 (CHROMIUM MOLYBDENUM STEEL.)
3. HEAT TREAT SPEC: SAE CONDITION N, 90,000 UTS.

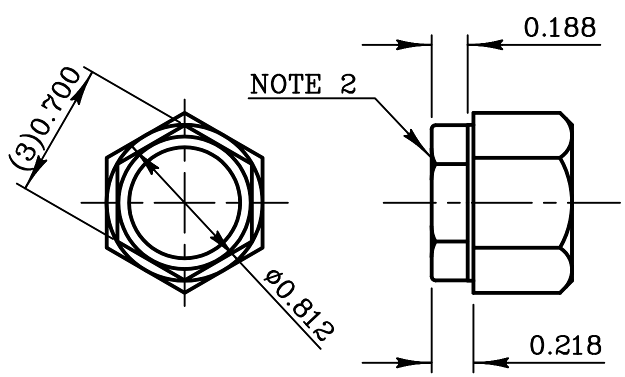
3/19/95 Configuration shown for 1936 Aero 600
DOUGLAS KEPHART, GLEN MILLS, PA. U.S.A.



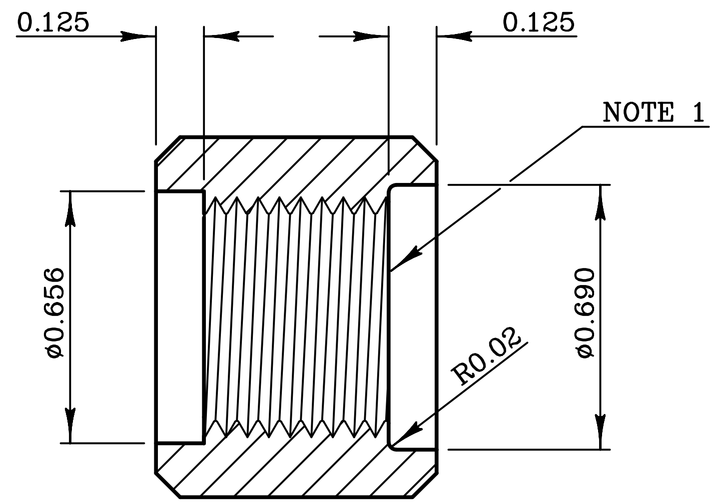
INSERTS FOR AXLE NUTS
0.135 THICK MILD STEEL



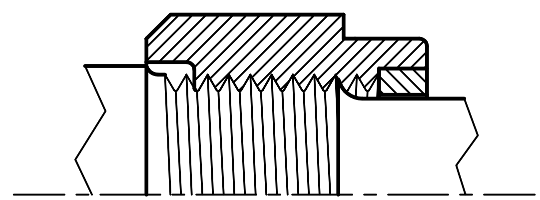
BACKING PLATE



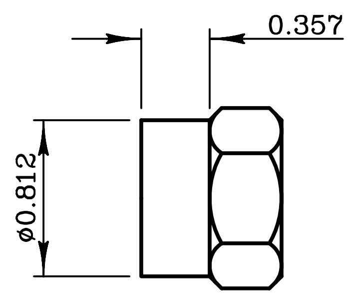
FOR BRAZED ON
DUSTCOVER



SCALE 2:1



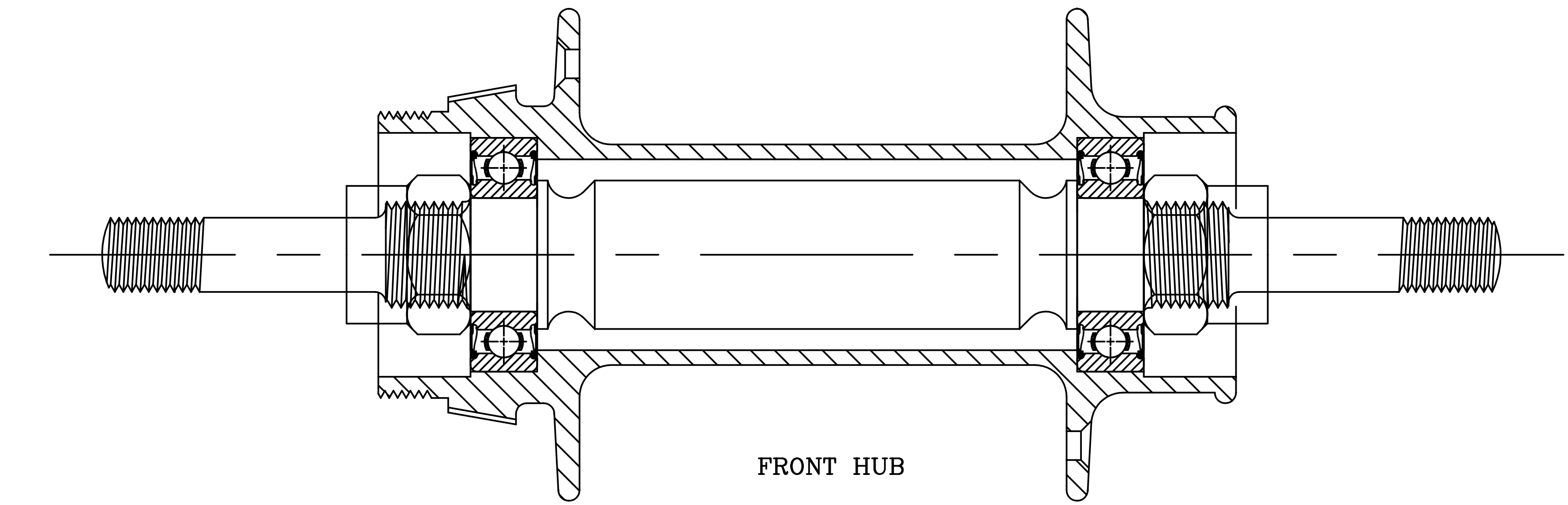
SECTION THROUGH OFFSIDE REAR NUT,
SHOWING POSITION ON AXLE



WHEN FITTED WITH
SPEEDOMETER DRIVE

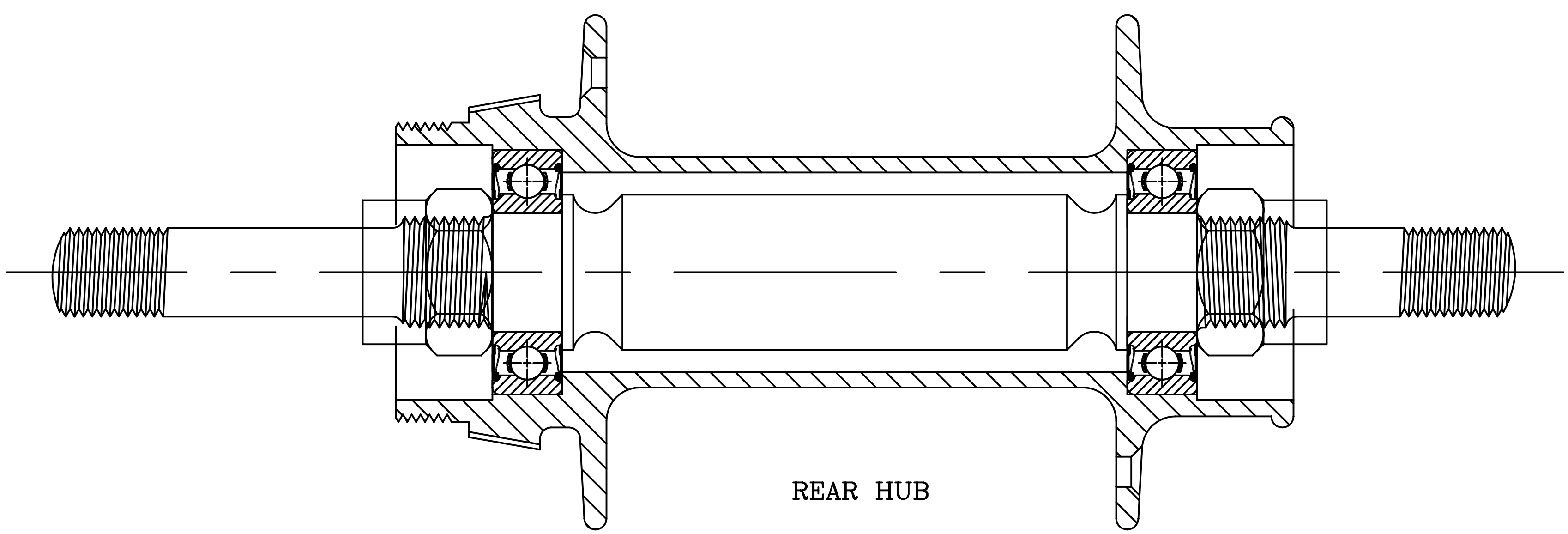
NOTES:
1. THREAD 5/8–18, R.H. OR L.H. TO SUIT AXLE.
2. RADIUS FACE EDGES OF HEX 0.02
3. FINAL LENGTH, AFTER BRAZING IN INSERT.
4. MATERIAL: MILD STEEL.

3/19/95 For new design Douglas wheel spindle
DOUGLAS KEPHART, GLEN MILLS, PA. U.S.A.

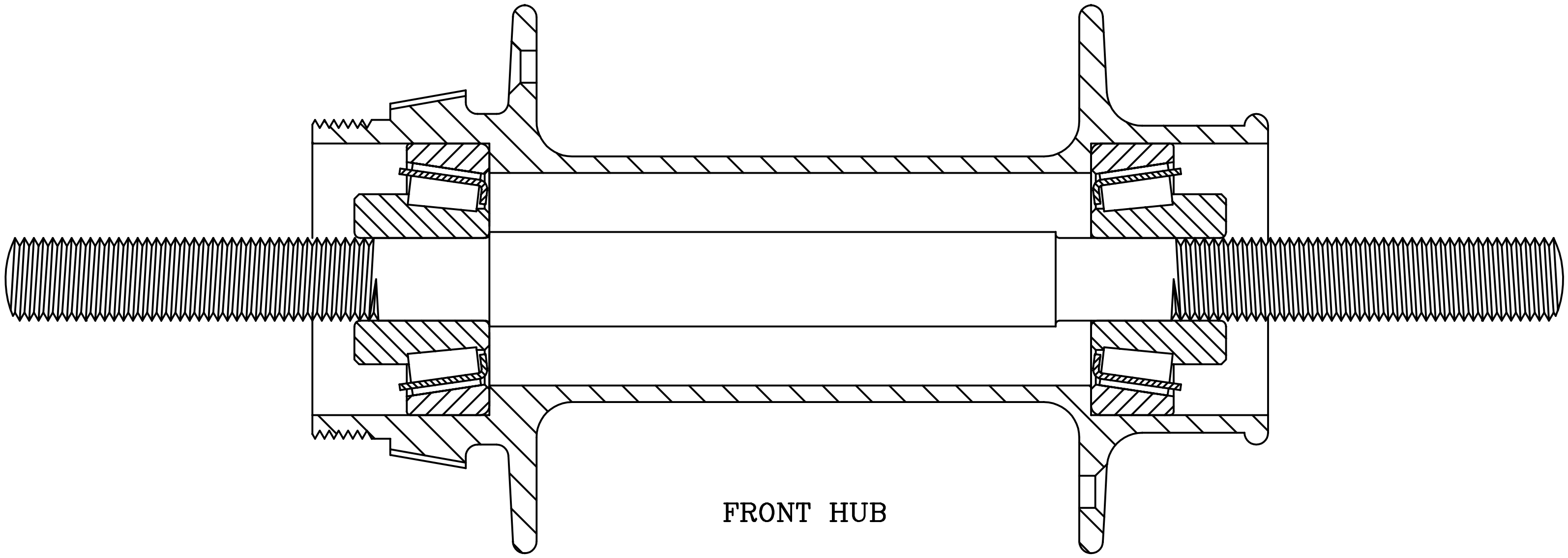


FRONT HUB

Improved hub and spindle for 1936 Douglas Aero 600

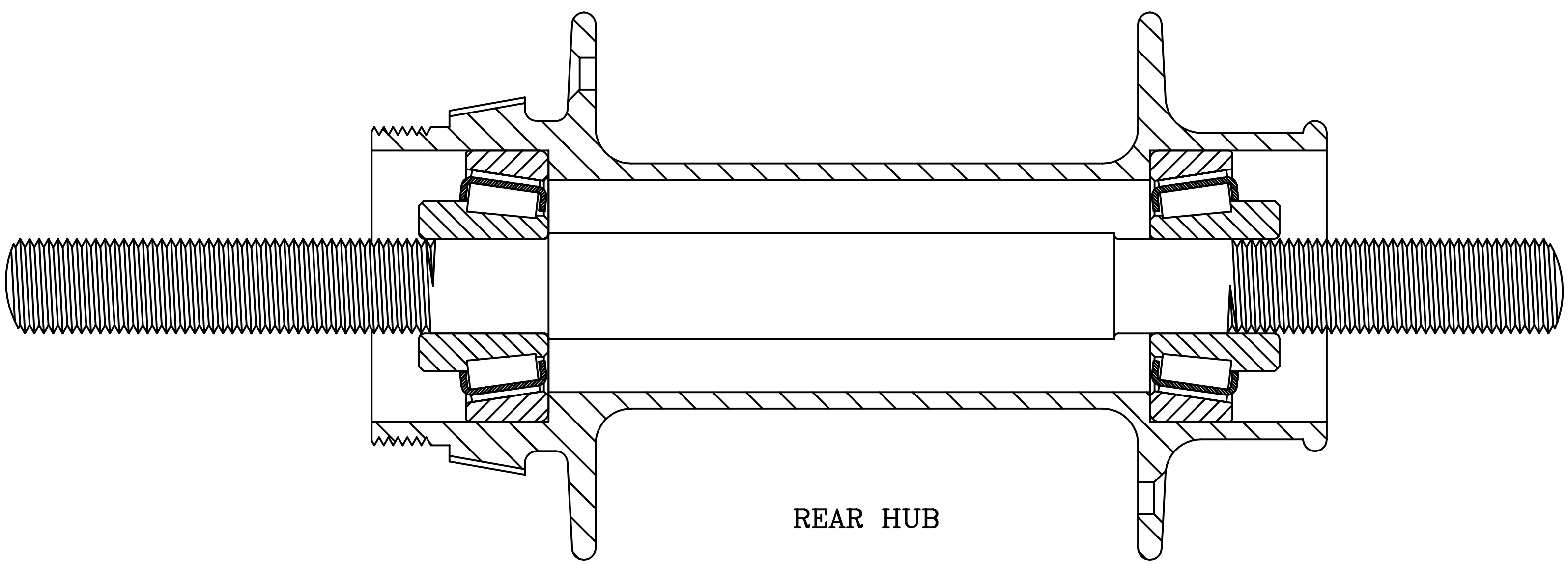


REAR HUB

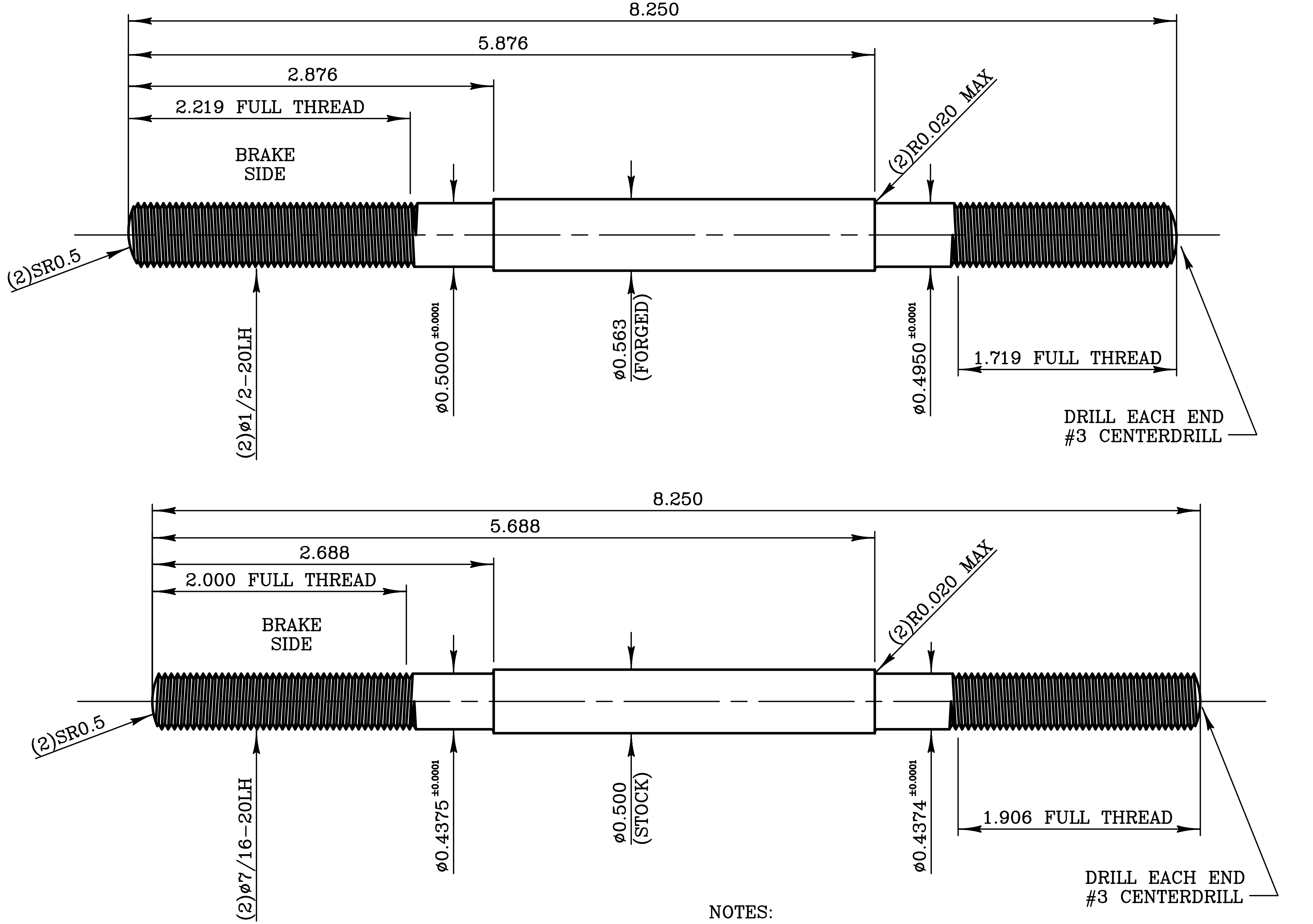


FRONT HUB

1936 Douglas Aero 600



REAR HUB



8/13/95 Pattern: 1936 Aero 600
DOUGLAS KEPHART, GLEN MILLS, PA. U.S.A.

NOTES:
1. TOLERANCE UNLESS SPECIFIED, ±0.005
2. MATERIAL: EN16, SAE 4130 CHROMIUM MOLYBDENUM STEEL.
3. HEAT TREAT SPEC: SAE CONDITION N, 90,000 UTS.