7.2 Two-Speed Gear

A JOURNEY INTO THE INTERIOR OF THE TWO-SPEED GEAR

Jack Frazer with support from Ken Lack

My first encounter with this intriguing device was a very long time ago, but in the middle thirties, when two-speed Scotts were at a discount, one didn't worry overmuch about what went on inside as long as the gears engaged sufficiently well to promote forward progress. If they didn't, one looked for another machine which would satisfy this important requirement and pressed on regardless.

Such a rough and ready approach, however, was not an option when, some five years ago, I started to overhaul and reconstruct the random components which now form IJ4934, the essentials of which are a 1923 frame and a 1925 engine, the whole forming an approximation to the 486cc Squirrel of that period. The gear that was fitted in the machine, as received by me, was in an advanced state of decay, but along with it came a box of rusty bits and pieces which appeared to show more promise, and it was upon these that I at first concentrated.

It so happened that at that time Ernie Scott's note on the fitting of needle roller bearings in place of the bracelets and balls appeared in *Yowl* (see Appendix) and, as a result of correspondence, he kindly sent me copies of Fox's and Rhode's modifications to the gear (also see Appendix). I decided to carry out these various suggestions when reconstructing the gear, but didn't tackle other equally important matters such as that of axial clearances, engagement of expander rollers in the clutch rings etc. Apart from making the Fox and Rhodes modifications I just assembled the gear, more or less, as the components came and hoped for the best. In point of fact this best wasn't too bad and it enabled the machine to appear at Banbury and Stanford (its first outing in living memory) and to complete about 1,000 miles over the riding season in 1988.

It was, nevertheless, obvious that further improvement could be made. Pedal travel was excessive and in moments of stress the gear tended to slip out despite operating with a tight band on the actuating drum. I decided to pull it down and investigate in greater depth.

In doing so various factors which I had not previously taken into account became apparent all of which have an affect upon the correct operation of the gear and these I now list:-

1. Axial Clearances/Wear: Unless you live on the side of a mountain (or in Yorkshire), the low gear drum is running free on the hub for 95% of running time whereas the high gear drum is locked to the hub for the same period. This means to say that most of the axial wear takes place between the narrow annulus of the N.S. of the low gear drum and the flange on the hub (Part Nos. 1188 and 1160). The standard remedy is to take up excessive axial float (over 1/16" says The Book) by increasing the thickness of the washers (Part No. 1172) on either side of the clutch ring assembly (i.e. between the Side Plates Part No. 1171 and the Drums themselves). This has the effect of increasing the axial dimension between the drums while the rings remain as before. I now suggest that a better plan is to take up the slack by inserting a hardened washer of appropriate thickness at the point where the wear has actually taken place i.e. between the N.S. end of the L.G. Drum and the flange on the hub.

In none of the gears which I have dismantled have I found wear at the high gear end, i.e. between the captive ring, no Part No. given, and the flanged securing ring (Part No. 1175) presumably again due to the fact that the H.G. Drum spends most of it's life locked to the hub. It should, however, be checked and taken into account in any attempt to make good overall axial wear. If the captive ring has to be removed or replaced, it necessitates removal of the magneto sprocket. This requires, so K.L. tells me, a special rig and much brute force: I myself haven't had to tackle it yet.

2. *Axial Clearance between Drums:* I cannot see any reason for making this greater than a running clearance between the rims of the drums, say .01"-.015". It is governed by the thickness of the two washers Part No. 1172 previously referred to. One can work out what it should be quite easily by measuring with a vernier the thickness of the double clutch ring assembly, subtracting this from the total of the depths of the two drums and allowing an appropriate clearance as above, thereafter dividing the result by two to obtain the thickness of two equal spacing washers.

3. *Engagement of Thrust Rollers with Gap in Clutch Rings:* This seems to be critical and should be such that when the Thrust Lever, complete with rollers, (Part No. 1164) is pressed into the ring to the clutch engagement point with the ring in its drum, the rollers should penetrate *beyond the radiused entries of the slot and just into the taper.* If this is not so, excessive pedal pressure will be required to maintain clutch engagement with consequent bad effect upon the thrust races in the Centre Thrust Sleeve (Part No. 1154). Not only this, but it will result in the band on the actuating drum having to be set unnecessarily tightly. The standard rollers as fitted are ¼" o.d. × 5/16" long, but I cannot believe that the former dimension is in any way critical, provided that the above condition is fulfilled: this depends upon the actual sum of the diameters of the two rollers required to expand the ring to engagement point. As it would appear that no two drums or rings are identical (what happened to the much vaunted Scott Gauge shown in the tool box transfer?) This necessitates a certain amount of selective assembly and general shopping around.

In the case in point, I found that standard ¼" rollers would not permit entry into the taper of either slot as above, and I accordingly turned up, out of mild steel, a series of pairs of rollers of various undersizes for trial. After playing around with these I found that a pair of rollers of .235" o.d. would permit correct entry into the L.G. ring slot when pressed into the ring within the drum but would not go beyond the radiused entries of the H.G. Ring Slot within its drum. What was required was to take a whisker off the flanks of the H.G. Ring Slot to permit the rollers to penetrate further. This presented certain difficulties as the ring is hardened on all machined surfaces, but was eventually done without disaster, on a homemade linisher by rigging up a suitable fence to preserve the correct angles, and rubbing down each side of the slot in turn until the Thrust Lever and roller assembly entered correctly. The two rollers were then given an unmerciful case hardening, and I found myself with an assembly in which the Thrust Lever and Rollers entered correctly and equally into both H.G. and L.G. rings at their respective clutch engagement points. I should emphasise that there would appear to be no particular merit in having the two rollers of equal diameter: what matters is the sum of their diameters in relation to the width of the slot in the clutch ring and the radial clearance between the ring and the drum.

4. *Drum Bearings:* There would appear to be available the following alternatives:-

1. Continue as before with the bracelet and ball arrangement
2. Square out the holes in the bracelet and replace balls with rollers (Tom Ward's modification)
3. Fit phosphor bronze or gunmetal bushes in the drums and running direct on the hub (Glyn Chambers modification)
4. Fit needle roller bearings running direct on the hub (Ernie Scott's modification)
5. Special rollers running in a Dural Cage with Drum and Hub ground to suit (Ken Lack's solution)

1, 2 and 3 require no particular comment as from my experience most drums and hubs are by now sufficiently badly "tracked" to require something more fundamental. I therefore concentrated on 4 (not having heard of 5 at the time). The most suitable bearing appears to be DNK 47/20A (INA, I believe) the dimensions of which are:-

Design o.d. of outer race	57 mm	with outer cage only
Design o.d. of inner Journal	47mm	
Axial width	20mm	

Against these dimensions one can set as follows:-

i.d. of Clutch Drum bearing surface	2.25"	=	57mm	+	.006"
o.d. of Hub bearing surface	1.875"	=	47mm	+	.022"
Length of bracelet bearing	.875"	=	20mm	+	.088"

These dimensions can be reconciled as follows:-

(a) Find someone with a cylindrical grinder who will reduce the o.d. of the hub to 47mm and at the same time true up, if necessary, the axial bearing face in the N.S. Hub Flange against which the L.G. drum bears (See 1.)

(b) Cut very carefully .003" liner brass to fit precisely into the drums and press the bearing assemblies in with a smear of "Loctite". This sounds crude but works better than it sounds: try a dry run first. Put the bearings as close to chain line as possible.

(c) Turn up a spacer ring axial width .088" to fill the space occasioned by the bearing being that amount shorter than the bracelet. (This may well not be necessary, but I did it to ensure that the needle roller assembly could not move axially in the drum.)

All this sounds worse than it is in practice, but this modification has behaved perfectly and on dismantling, shows no wear or distress after about 1,000 miles. I should say that the reduction in diameter of the hub o.d. did not appear to affect the case-hardening: the new surface appeared no less hard than the original.

Since writing the foregoing K.L. has pointed out that where needle rollers are employed running directly on the hub, with line rather than point contact as would be the case with balls, the radial clearance within the bearing as a whole should not be greater than that which will just permit the drum assembly, complete with bearing, to slide on to the hub. This implies that for the aforementioned caged needle roller bearing, the hub diameter should be only fractionally less, say .0005", than the design diameter of 47mm. In the gear which I have built using these bearings I know that I have over-stepped this limit: although no ill effects have been observed to date I shall take this into account for the future.

He, furthermore, makes a point which I had entirely overlooked. This relates to the reduction of .022" in the hub diameter to accommodate the bearing: this affects the two side plates, Part No. 1171, supporting the clutch rings. In order to support the rings coaxially with the hub and drums, these should be a neat sliding fit on the hub. Thus two new rings with an internal diameter reduced by .022" will be necessary to preserve this alignment, I did not appreciate this point when assembling my gear, but although no ill effects have been noted up to the present, will act accordingly the next time round.

5. Thurst Bearings in Centre Thrust Sleeve: The original large ball/no cage arrangement leaves much to be desired, but direct replacement is possible using either the normal caged thrust races (FT ⅞) or, more trendily, the radial needle roller thrust washers (NT 1423 Torrington, I think). In both cases it may be necessary to reduce the width, by one means or another, of the various thrust washers and lock nuts so that the new assembly can be accommodated within the length of the Centre Thrust Sleeve. I can vouch for the FT ⅞ arrangement but have yet to try the needle roller alternative which is about to be fitted in my spare gear.

6. W.C. Fox's Modification to ensure better Lubrication: I have caried these out, but I cannot say whether thay have made an improvement or not as I have had not problems in this respect. I cartainly believe they do no harm. I have not, as yet, attempted to carry out his elegant modification to provide hand engagement of low gear as I don't often find myself in situations where it would be helpful i.e. starting on steep hills.

7. Gearing: The question of sprocket size/chain length has been dealt with fully by Rhodes (See Appendix). In *Yowl* Vo. 9 No. 6 he establishes by use of a formula and arithmetic that, with engine sprockets of 20T and H.G. sprocket of 25T, the only L.G. sprocket that will provide equal tensions on both chains is a 42T. This is doubtless so, but it only holds good if all the sprockets and chains are equally new or equally worn. In my case where there are new L.G. and engine sprockets but a well used H.G. sprocket, chain tensions are by no means equal. Nevertheless, a 42T wheel gives a good compromise between the standard 46.47 tooth wheel and the close ratio wheel of 40T. (I have two low gear drums with 36 Teeth!) and is certainly more suitable for general use than the former.

One small point is worth making in regard to riveting on new sprockets to drums. Each sprocket is riveted on to its drum by 6 Flathead steel rivets. I was not able to find a satisfactory commercial alternative for these, but it was a simple matter to turn up the necessary quantity from MS Bar making the shanks a neat fit in the sprocket and drum holes, and the heads slightly thinner than the spacing washers used (Part No. 1172). If this is not done the heads of the washers may bear on the side plates (Part No. 1171) and the axial clearance of the drums will be adversely affected. Use Black Bar (Concrete reinforcement rod is good) which is softer than Bright Mild Steel.

8. Special Tools: The only special Tool (apart from the simple gadgets mentioned in a former effusion) which is desirable is a thin ¼" Ring Spanner to ensure tightness of the Thrust Lever Pivot Pins (Part No. 1165) which are not readily accessible to a normal ring or set spanner. I made one up from ⅛" Plate with a hexagon hole at either end (the one offset by 1/12 of a turn from the other).

9. New Components: In the course of all this I have made up two new Spindles (Part No. 1152) and two Push Rods (Part No. 1153). These are straight forward turning jobs, the former in EN8 (I think) and the latter from long H.T. Bolts. I have drawings of both if anyone is interested.

Where does all this tedious mass of stuff get us? Without, I hope, appearing to be presumptuous it seems to me that it could justify an attempt to produce a Child's Guide (or Critical Path if you prefer it) for anyone wishing to build up one of these gears from scratch. Perhaps something along the following lines:-

Step A Decide what, if anything, you are going to do about H.G. and L.G. sprockets and do it (See 7.)

Step B Decide what you are going to do about the internal thrust block bearings and do it (See 5.)

Step C Decide what you are going to do about the drum bearings and do it (See 4.)

Step D Check that Lock ring (Part No. 1175) has a good thrust face against Captive Ring (No Part No. that I can find) in O.S. end of H.G. Drum and that Lock ring flange butts home on end of hub when fully screwed in. Rectify as necessary.

Step E Check condition of thrust face N.S. end of Hub and rectify as necessary (See5. (a)). Place both drums only c/w bearings on the hub and screw home lock ring (Part No. 1175). Measure with feelers total axial float between N.S. end of L.G. Drum and flange on Hub. Make a hardened steel washer of this thickness less a working clearance of say, .02" (See 1.)

Step F Measure up Drums and Rings (See 2.) and ascertain thickness of two washers (Part No. 1172) which will give .01"-.015" axial clearance between rims of drums, and so provide. While measurement gets one fairly near, I found it helpful to make up trial washers in MS (out of car body washers) to ensure that I had got it right before embarking upon the hardened washers themselves. These hardened washers are beyond the capacity of my modest shop as I have no grinding facilities, but Ken Lack can produce to one's requirement.

Step G Carry out the procedures as outlines in 3.

When you have done all this you will, I hope, have the makings of a gear which has minimal axial clearance (which reduces pedal travel) and correct clutch engagement, but I make no reference to the main cup and cone hub bearings (for which no obvious modern replacement exists, although there may well be a needle roller wolution which I have not investigated): they can be made good by regrinding or direct replacement as may be most appropriate. Nor do I think it necessary to enlarge upon the procedure for assembly as it will become evident to you as you progress through the procedures suggested above. These gears are a compact and ingenious example of early twentieth century mechanical engineering and are of surprising robustness. It is remarkable how well they perform even when in poor condition, but even more so how they respond to a little care and attention.

APPENDIX

2 Speed Gear Bibliography

I have been through the Indices of *Yowl* and list below the principal articles connected with 2 Speed Gear which have from time to time appeared:-

(a)	Vol. 1 No. 6*	General notes — Ward
(b)	Vol. 3 No. 10 *	Various modifications — Fox
	Vol. 4 No. 1	
(c)	Vol. 4 No. 8	Letter — Slipping Gear
(d)	Vol. 8 No. 3	Repairs to gear spindle — Reeves
(e)	Vol. 8 No. 6	Manufacture various parts — Reeves
(f)	Vol. 9 No. 4*	Sprocket Problems — Rhodes
(g)	Vol. 9 No. 6*	Sprocket Problems (Contd.) — Rhodes
(h)	Vol. 11 No. 10	Hand clutch (Wire and Drum)

(i)	Vol 14 No. 1*	Needle Roller Bearings — Scott
(j)	Vol. 14 No. 4*	Bronze bearings in lieu of Bracelets — Chambers
(k)	Source unknown*	Scott Gearbox & Clutch — Kelly (Scott Motors Ltd.)

Many thanks to the Club Librarian for providing copies of several of these.

I have marked with * those of particular interest.

Ed: Within a few days of receiving the foregoing article from the Emerald Isle, I also had the following "Reeves Wrinkle" which was ideal for tagging onto the end of Jack's superb contribution:-

OIL SUPPLY TO TWO-SPEED GEARS.

For some years now I have been collecting two speed spares as and when they have turned up. On recently checking up on my stock I found that I had all the difficult bits i.e. sprockets, hub, thrust block etc., so I decided to make the missing items and thus have a spare set of gears.

I made a main spindle, a cone, a sliding sleeve, two lock nuts, a thrust rod and a sleeve nut.

As you may know there is no problem in getting an oil supply to the low gear side but getting it along to the high gear and keeping it there presents a real problem.

To attempt to alleviate the difficulty I reduced the diameter of the thrust rod for part of its length and also drilled a 1/32" hole where the fixed cone is on the spindle (high gear side) a thick felt washer fitted on the distance piece (low gear side) helps to keep the dirt out and oil in.

It is, however essential to mark the end of the gear spindle so that the slot in the spindle is horizontal otherwise the oil will just run out.

Another modification first suggested by a Mr Fox many years ago is to alter the slot in the gear rings to about 5 or 6 degrees and smooth them to let the rollers slide in. This reduces the load on the thrust bearings.

I have not as yet devised a method of keeping the oil from escaping below the high and low gear drums but I am working on it.

George Reeves

THE TWO-SPEED GEAR REVISITED
Jack Frazer, Assisted by Ken Lack

I am very conscious that the majority of readers of *Yowl* will by now have had enough from me about the above to last them a lifetime. Nevertheless, the subject is almost inexhaustible and I hope that I may be forgiven for this further intrusion, covering some points which were missed in my previous effort and which may be helpful to others confronted with two-speed gear problems.

1. Clutch Rings and Side Plate

When assembling a gear, particularly when it is being done from random parts, it is important to ensure that the Side Plate Part No. 1171 is firmly held by the register in the ring. If it is in any way loose, the ring will not be truly centred with the hub via the side plate and unauthorised contact between it and it's drum may take place when in the neutral or disengaged positions. This applies, of course, to both HG and LH Assemblies, but to ensure that all is as it should be is not quite as straight forward as it would at first appear.

The final Ring/Side Plate assembly must be such as to ensure that, not only is the side plate firmly held within the ring, but that, when so fitted the radial clearance between the ring and the drum is no greater than that which will be sufficient to ensure freedom within the drum when in the disengaged position. If this radial clearance is excessive, unnecessary axial travel of the push rod will be required to engage the clutch with consequent additional pedal travel.

To obviate this it may be necessary to fit a side plate of slightly greater O.D. than standard (which is apparently $3^{15}/_{16}$"). It is difficult to be precise about what this radial clearance between ring and drum should be, but as long as the ring and side plate assembly is just free in the drum in the disengaged position all should be well. To be absolutely correct, I think the side plate should be fitted so that the ring will just not enter the drum, and the whole ring/plate assembly subsequently ground to provide the necessary radial clearance. Not everyone, however, has a grinder at his disposal and it should be possible to obtain an acceptable result by gradually reducing the O.D. of the side plate until the ring will just enter the drum, thereafter, identifying any high spots on the ring with blue and removing them with a slip stone to give free operation.

At this stage, I must remind you of two important points touched upon in my previous note, and which bear repeating.

(a) If a new side plate is being fitted for whatever reason it is essential that the I.D. of the plate should be such that it is a close sliding fit on the hub. Thus, if the O.D. of the hub has been reduced to accept needle roller bearings, say to 47 mm, the side plate I.D. must be reduced correspondingly. This will necessitate a special plate as previously mentioned.

(b) Do not overlook the importance of ensuring that, with a given set of expander rollers, the movement of the expander ring required to engage both High and Low Gear clutches is, as near as possible, the same. This is best done after sorting out the side plate situation so that the radial clearances in both Clutch Drum/Ring assembly are equal. Select a pair of rollers which will give correct entry into the ring with the *wider* tapered slot and subsequently relieve the sides of the narrower slot in the other ring to give equal engagement (or expansion) in both assemblies.

If you have an assortment of Drums and rings, selective assembly may help you here, but if not the above procedure should give a satisfactory result.

2. The Five Start, Quick Thread Drum and Sleeve (Parts 1195 - 1199)

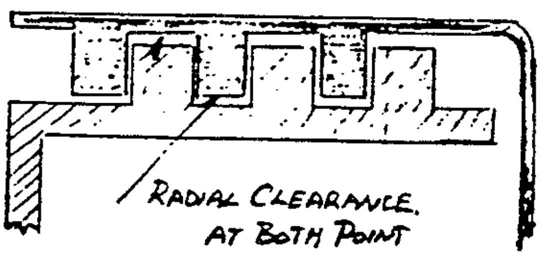
This combination has a very essential duty to perform and has a pretty hard time of it being exposed, not only to the elements, but to whatever contributions descend from the rider's boot! The result of this is that all the drums and sleeves which I have encountered have been badly worn.

This wear is of two kinds:-

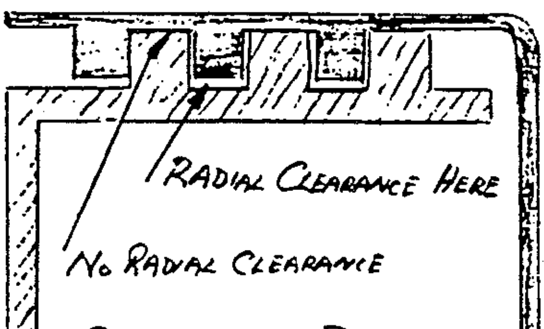
(a) Wear in an axial direction between the *flanks* of the threads on both the sleeve and the drum. This introduces lost axial motion between drum and sleeve, thence to the push rod and leads to increased rotational pedal travel between HG and LG engagement points. I see no simple way of making this good.

(b) Wear in a radial direction between the *crests* of the threads on the drum and the bottoms of the threads in the sleeve.

It should be appreciated that this radial clearance is critical to the operation of the assembly as, if it is not correct, no amount of tightening of the band round the sleeve will produce the necessary "stiction" to ensure that the gears stay engaged and at the same time preserve a free neutral position. This "stiction" is caused by the fingers on the sleeve riding up on the ramps on the drum threads when the sleeve is



NEUTRAL POSITION.



GEAR ENGAGED POSITION

ie. DEPTH OF THREAD IN SLEEVE MUST BE LESS THAN THAT OF THREAD ON DRUM

ROUGH SKETCH SHEWING CORRECT CLEARANCES BETWEEN QT DRUM & SLEEVE

JWF 4 90

moved from the neutral position toward either gear: it will not come about if the ramps or sleeve are worn to an extent which permits the crests of the threads in the sleeve to bottom on the root diameter of the drum. If the necessary clearance exists very little tension on the band will be necessary to ensure that the sleeve stays put in either gear position. *See sketches.*

I see two ways of improving this situation:-

(1) After carefully noting and recording the position and extent of the 5 Neutral position cutaways on the drum, get a skilful welder (not me!) to build up the crests of all the threads, machine off true to whatever O.D. you consider represents standard and restore the five cutaways by judicious filing. I have not tried this but intend to do so.

(2) A crude but apparently effective alternative is to take a 3⁄16" square file and restore the radial clearance by carefully filing round the root of each of the threads on the drum thus effectively increasing their depth. I have tried this with success, but one has to be careful not to let the file bear on the *flanks* of the threads thus adding to the prejudicial axial clearance already covered in (a).

There is of course, the third alternative of paying a visit to Sheffield and coming away with one of K.L.'s well constructed replacement assemblies, but this is perhaps a council of desperation and not for those whose priorities lie in other directions (in my case a new radiator).

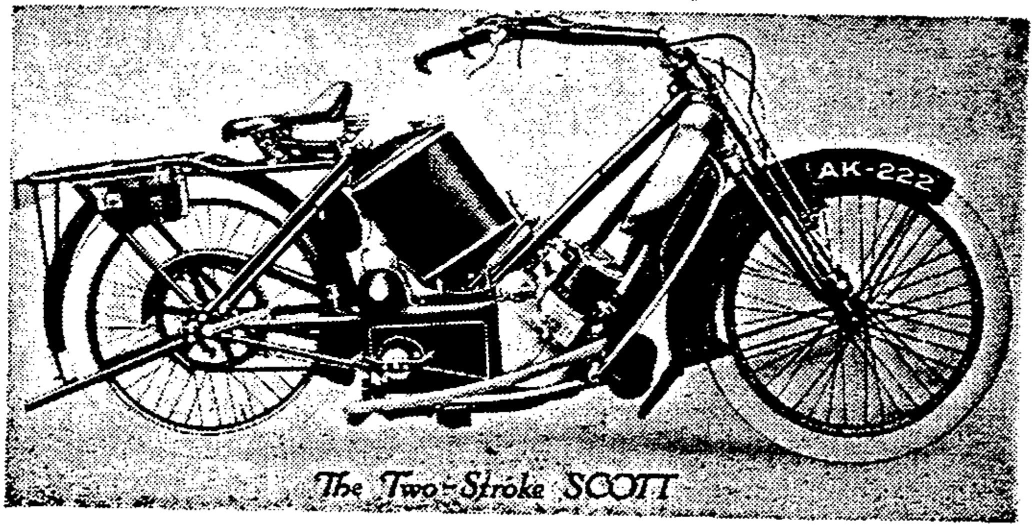
3. Clutch Rings

When assembling a gear from random parts it is not impossible to find that the only ring available will not enter your chosen drum at all. How this comes about is not for me to say: whether the rings expand in old age or whether, when that particular specimen was being finished, the Scott limit gauge was having a day off, is neither here or there. The situation can, however, be rectified with the aid of a large vice by giving the ring a series of judicious squeezes on several diameters. I have a feeling that if you squeeze too hard it will break, but in my case I was able to persuade it to enter the drum and give clearance without this happening; in this I may have been lucky.

K. L. advocates the application of heat to the pivot point of the ring (i.e. at 180° from the tapered slot) before applying the squeeze, but this raises problems of handling a hot and uncooperative object. Possibly a good pair of blacksmith's tongs are the answer here.

An attractive alternative could be to lay the ring flat on a couple of fire-bricks, heat all over to taste and apply the squeeze by a substantial Jubilee clip with additional length riveted into it to enable it to encompass the ring. This sounds good to me, but I haven't tried it (nor, I believe has Ken).

J.W.F.



The Two-Stroke SCOTT

SOME GENERAL NOTES ON THE SCOTT TWO-SPEED GEAR.

by Tom Ward.

My experience of this gear is based on the fact that my firm at one time had over 500 Scott Riders on it's books, and we overhauled hundreds of these gears, which must have done a combined mileage of many millions of miles. They stood up to that remarkably well, but naturally we came across a few recurring troubles. I will try to give a list of these:—

HUBS SCORED ON BALL TRACKS.

Our cure for this was at first the bushing of the drum with a plain phosphor bronze bush. Then we went on to needle rollers as per Hemmings, but finally we found the most satisfactory method was to broach the $\frac{3}{16}$" holes in the brass ball cages into perfect squares and then fit $\frac{3}{16}$" Hoffman steel rollers. This made a 100% satisfactory job. Of course, it was necessary to replace the worn drum and hub if the wear was more than very slight.

THRUST RACES BADLY WORN.

This nearly always coincided with excessive thrust loading due to the thrust rollers being too big to enter the gradual taper portion of the expanding ring gap. When pushed home the rollers should just top the rise at the curved entrance to the gap. After topping this rise the going is easy and there is no excessive thrust set up in the bearings.

EXPANDING RING DRAG.

Just once in a very long while we used to come upon this trouble. A ring had, for some reason, opened out slightly until it acted as a permanent brake when it should have been quite free. The braking caused overheating until the ring became blued and braked harder than ever with great loss of power when in the other gear. If you suspect this trouble at any time feel at the gear after pulling up, or pull the rear wheel round in neutral.

CUP AND CONE WORN DUE TO EXCESSIVE THRUST ON THAT SIDE.

Expanding ring gap to narrow for thrust rollers to 'top the rise.' Remedy is to try different rings until you find one just right. Always see that the cups have a groove at back for oil to circulate to the hub bearings. Otherwise they never get any oil.

TWO-SPEED MODIFICATIONS

Undoubtedly, much of the enthusiasm with which the Scott was greeted when it made its debut, about 1908 or may be earlier, was due to its two-speed gear and kick-starter — two things motorcyclists regarded as almost unattainable perfection at that time. Naturally Scotts were complimented by the riders, and the writers, of the day. And naturally, too, Scotts were proud of their gear, but that pride gradually turned into a haughty distain of any suggestion for alteration or improvement — "we know what we are doing" — and that in its turn developed into a sort of mystique and worship under which the gear was sacred and not to be touched or altered in any way. The result was that when, somewhere about 1930, the gear was quietly dropped in favour of the more complicated and heavy gear-box, it was still the original item, direct from its introduction, with all the initial faults and failings. Two of these faults I hold, were fatal to the satisfactory operation of the gear-oilng and the technical application of the ball bearings.

Oiling was critical and nothing was ever done about it. Anyone looking at the quite good technical drawings of the gear which Scotts published in the Book of the Scott will quickly realise that the oil was led in to the centre of the gear and there released to its own devices and these were, under the impulsion of centrifugal force, to get outside the gear as quickly as possible — an activity in which it was singularly successful. The underpan, the flywheel, the underside of the magneto and anything else in the centre line of the machine was always in a mess from the oil escaping from the gear. But, the main cup-and-cone bearings on which the gear ran never, under any conditions, got any oil and the constant demand for 7/- or so for cups and cones and balls speedily became a little wearying. Particularly as those parts needed renewal as frequently, or rather more so, than de-coking was called for. Older riders will remember, perhaps with amusement how, how long it was before engine designers realised that valves and guides would benefit enormously from total enclosure and proper lubrication. Ball bearings suffered from the same curious neglect, and going back again to that machine drawing a careful inspection will reveal that the two-speed gear was singularly exposed to all the water and filth found in such good supply about six inches from the surface of the road. Round each cone was an annular space at least 1/16 in. in width — if not more — giving direct access to the balls. And the two gear drums in the centre of the gear had a space of appreciable dimensions between them, through which the oil poured out and through which water, dust and dirt freely entered. True there was the underpan and the gear shields, but they were more eye-lotion than any effective protection for the vital parts of the gear.

There then was the basic problem, how to stop the oil getting out and the water getting in. As a first step the cup-and-cone main bearings were given some protection by turning up a light steel disc which just slipped over the spindle and fitted butted up against the outside face of the cone and practically closed the annular gap already referred to. One was fitted to each side of the gear and although the effect of them was to slightly increase the overall width of the gear between the lugs, it was largely adjusted back to the right width by the removal of some of the washers used to adjust the clearance of the kick-starter ratchet. Lubrication, however, was a different matter. There is practically no room for any tricks inside the gear and the oil had to be got to the cup and cone bearings. The gear runs on a hollow spindle rigidly mounted between lugs. Oil is fed in to the near side through the spindle, but the off side carries the operating rod — a nice sliding fit in the spindle continuing right along to the middle where a ¼ in. diameter cross rod takes the movement of the operating rod to a sleeve. This slides on the spindle and provides a mounting for the ball-bearing thrust washers which carry a thrust block actuating the ring expanding lever. This expands one or other of the gear rings and so links that gear to the final drive. The gear operating rod is a most effective cork preventing any oil getting to the right hand side of the gear. Not only so, but at the point where the ¼ in. cross pin comes, two slots in the spindle about an inch in length and ¼ in. in width are needed to give the cross pin clearance. That provides a most efficient opening through which the oil could escape — and to make quite sure it did, two shallow channels were cut in the spindle continuing the slots to left and right. Over all this openwork slid the sleeve to which the ¼ in. cross pin was rivited. And the sleeve was provided with four holes 'for lubrication purposes'! On top of all this glorious unsatisfactoriness the spindle is entirely unlocated in a rotational sense. One could get the ¼ in. cross pin vertical or horizontal or in any of the other 360 positions of rotation that were possible. For a start the spindle was clearly nicked at the kick-starter end where the operating rod comes out so that when assembling the gear in the frame one could be quite sure of getting the ¼ in. cross pin horizontal and in one only of the two positions possible. This was necessary so that one could ensure that one point, and one only, was always 'top' when the gear was in position in the frame, and, more important still, that one point and one only was 'bottom.

This positioning having been established a 1/32 in. hole was drilled in the hollow spindle close up to the shoulder on the near side end of the spindle up against which the thin adjustment washerse but to give the correct adjustment of the main bearings. It was considered that the oil coming into the spindle would 'drip' from the small hole — and sometimes less than 1/32 would be preferable — get on the cone and so come in contact with the balls. Assembled and run on the road for a time this idea certainly worked. Not only so, but the oil worked its way through the bearing on to the locking ring, from that on to the final drive sprocket which the locking ring holds in chain — an unexpected benefit most cheerfully accepted.

A similar 1/32 in. hole was drilled at the off side end of the spindle and in the same relative position to the cone on that end, though here the problem was to get the oil past the thrust rod which filled all the right hand half of the spindle. Furthermore there was so little metal in the parts that at first sight it did not seem possible to cut any oil-ways. However a start was made at the middle by filling in with solder the channels cut in the spindle in continuation of the central slots; and three of the four holes in the sleeve were similarly filled in. Taking a hint from the two continuation channels which had been filled in with solder, a short channel was cut in the bottom on the spindle at the point where the two slots came. This oilway was kept as short and as shallow as possible so as not to weaken the spindle. In addition the inner edges of the slots, at the bottom, were bevelled off to provide small channels giving clearance past the quarter cross pin. This arrangement got the oil very satisfactorily past this difficult position in the centre of the gear. To carry it right along to the right hand side the thrust rod was provided with a number of shallow 1/16 th. in. channels turned in it rather like a number of piston ring slots. These were arranged at about ½ in. intervals and the one on the extreme right so positioned that it moved directly over the 1/32 in. hole every time the gear was operated. These channels were connected one to another by a series of short slots alternately top and bottom on the thrust rod, the idea being that they would, under gear operation, collect oil and pass it on one to another to the last annular ring which would under the same gear operation, release it through the 1/32 in. hole. When tried out on the road this was what happened and for the first time the left and the much more important main bearings were satisfactorily oiled. Apart from the greatly extended life of the bearings there was another advantage. The oil tap from the tank to the gear could be 'forgotten' in the 'on' position for long periods without all the oil in the tank being found underneath the machine. Acting on this hint a drip feed was arranged from the main oil line to the gear, parts from a conventional drip feed being used, but without the glass, and the whole hung in the oil pipe line. (to be concluded).

(W.C.Fox)

* * *

TWO-SPEED MODIFICATIONS.

(*PART* II).

by W. C. Fox.

During operations on the lubrication problem the other ball bearings in the gear received consideration. The high and the low gear drums run on single line ball bearings kept in position, because the diameter is large, by bronze "bracelets." But, because the pull on the drums is diagonal and with a tendency to wriggle when the gear is engaged, the arrangement was not entirely satisfactory and the balls tended to track both the hub body and the inner surface of the drum. One inch by three sixteenth inch needle rollers were tried, but the possibility of the needles getting across the correct line of rotation suggested results too horrible to risk. Instead, Tom Ward of Derby, whom every right minded Scott enthusiast seems to know, was asked to convert the bronze bracelets to take 3/16th "square" rollers. This alteration was a definite improvement but still lacked some refinement. Finally dural "bracelets" were used giving a wider area of bearing and using fewer rollers.

The other bearing, which from time to time failed, was the central thrust bearing carrying the gear expander ring operating lever. As a bearing it was simple in the extreme, just four hardened and ground flat surfaces separated by two rings of very large balls kept in position by two very light steel rings. If one could have run it in a bath of oil it might have worked, but as the bearing was running in a horizontal position any oil present was immediately flung off by centrifugal force and sooner or later the balls "scurfed," jostled one another and created enough pressure to burst the light retaining ring—and one had no gear at all and walked home. A search through the catalogues of ball bearing manufacturers disclosed one firm producing a ball bearing thrust washer of almost the exact dimensions required. It consisted of two rather thin hard steel plates with a thicker bronze plate between containing the balls and affording no opportunity for one ball to rub against another. Furthermore the plate was only a little less thick than the full diameter of the ball and could, therefore, act to a certain extent as an oil retainer. While Tom Ward was in process of fitting these washers—there was a slight amount of careful work necessary—he casually remarked, in the correspondence on the matter, that it made a great difference to the loading on the thrust washers if the expander rollers in the end of the operating lever fully entered the "V" slots in the gear rings before they began to engage. If they rode on the rounded shoulders of the "V" slot, even to the slightest extent, the loading jumped up considerably. A small but important point—and with a curious outcome. It revived a long cherished desire to have a hand operated clutch on the two speed gear.

Anyone who has been stopped in the middle of a steepish hill, particularly in heavy traffic, and has been faced with the problem of getting the gear into engagement without stopping the engine, or starting off like a bomb, will appreciate the difficulty and the need. The necessary parts were sent off to Derby with a double request : "a," that the slots should be brought into line with the correct entry requirements and "b," that the included angle in the rings should be altered so as not to exceed three to four degrees—the standard angle as used by Scotts seemed to be about 10 degrees. This work was done with the beauty and precision of a tool-room job and several immediate benefits were evident. The gear was infinitely smoother and convenient in operation, and very light in addition. Also, the friction band on the quick-thread nut wanted very little tightening and retained its adjustment very much better than formerly. In addition it was found that low gear could be fully engaged by thumb pressure only on the end of the actuating rod. (Low gear is engaged by pushing the thrust rod towards the near side of the machine by means of the quick-thread nut). Do the pushing by means of a suitable spring and hand operation by handlebar lever, giving all the advantages of a clutch became possible. This however entailed a certain amount of simple lathe work and some definite alteration to the quick-thread nut and gear pedal and to the hollow bolt anchoring the near side end of the gear spindle. The first thing was to find a suitable spring to push the gear into engagement. Because the gear pedal is held to the quick-thread nut by two studs 1¼ ins. apart, this severely limits the size of spring. unless one wishes to drastically re-arrange the mounting of the gear pedal on the nut. A suitable spring of about ¾ ins. diameter, a free length of about 1½ ins. and composed of some three to four turns of 1/8 wire, was found. (Possibly one of a set of clutch spring from a car). Full compression, some 200 lbs. or more. A housing for it was turned up from a length of 2 ins. steel rod. This was first drilled ¾ ins. and then cleared to allow the spring to slide easily but without undue clearance. The overall diameter was reduced to little more than 7/8 ins., but a flange ¼ ins. thick was left on one end and the other was provided with a threaded portion some ¾ ins., in length, 26 t.p.i. for the retaining cap. A grease nipple was put in the centre of the cap. The total length of this housing depends on the length of the spring secured and how much the shouldered ¼ in. nut in the end of the thrust rod projects beyond the outer face of the quick-thread drum. The flange on the spring housing was drilled with two ¼ ins. holes positioned to slip over the two studs in the quick-thread nut which retained the gear pedal. The gear pedal itself was scrapped and in its place a piece of 1/8 ins. steel plate 2¾ ins. wide and some four ins. long was provided.

In the centre of this the spring housing was riveted, clearance holes being provided for the spring and the two quarter studs. A gear pedal was fabricated from suitable steel strip and pieces of aluminium rod and riveted to the plate. The spring retaining cap was made about ¾ ins. in length to make it possible to assemble the whole without having to first compress the spring. Also the long cap provides a means of adjusting the thrust exerted by the spring. When assembling with the spring box it is necessary to make sure that the thrust rod can pass freely through the quick-thread nut. In the original Scott arrangement a fairly large diameter washer on the thrust rod and immediately behind the shouldered ¼ ins. nut transferred the movement from the nut to the rod. With the spring in use make sure that this washer is left out.

A normal handlebar clutch lever and Bowden cable were used as controls and the motion is transferred to the spring by normal type clutch mechanism —which one has to make for oneself! Disengagement of the gear is secured by pushing on the end of the actuating rod against the pressure of the spring fitted on the quick-thread nut. To do this a rod has to be passed through the hollow retaining bolt at the near-side end of the gear. For this purpose a piece of 3/16th silver steel rod was used and the standard hollow bolt was replaced by one at least a quarter of an inch longer and with a head of increased length to provide room for a packing gland. The oil travels down the hollow bolt, but as a piece of rod is being put in the centre of the bolt, oil channels have to be provided to ensure the oil supply to the gear as a whole. Cork, from the metal caps found on beer bottles, was used as packing in the gland because it was easily cut, and more important still, cork makes a much better, friction free, packing than either cotton or hemp and is a much tighter joint. The clutch actuating arm will need a fulcrum point. This can be provided by a piece of 3/16th steel plate locked under the head of the hollow bolt. It has to be fairly thick so that it may not flex under spring pressure when the clutch is operated. Into this piece of plate, and as near to the bolt head as possible, a yolk, made from a piece of 5/8th steel rod, is screwed. It is as well to turn the rod down to 1/4th and thread it 26 t.p.i., having of course first formed the yoke end to take the operating lever. The lever itself is best made from a piece of steel bar, 1/4 by ½ ins., drilled at each end to take the fulcrum pin and the anchorage for the bowden cable.

A mechanical advantage of something of the order of six to one is about right for the lever and this will make it of such a length that it will come at the long end, just above the main back fork member which runs from the main engine bolt to the back axle. Anchorage for the bowden cable can conveniently be arranged from the adjusting lug on the frame for the magneto platform. (In my case coil ignition had caused this lug to be without employment).

This alteration provides a clutch action on low gear only. In neutral and top gear there is no tension on any part of the bowden cable so in the interest of keeping things generally together it is well to put a suitable coil spring over the exposed length of inner bowden cable between the stop and the end of the lever. No very great pressure is necessary, just enough to stop the handle bar lever rattling or the cable jumping out of its housing. If the making of "bits" and the general fitting up has been done with reasonable care the clutch action will in service be found to be precise and with no back-lash, while the grip required should not be beyond that which can comfortably be applied by any normal hand. It is perhaps worth commenting that although this alteration work was done some years ago now, constant use has merely indicated the advisability of having the bare metal parts properly plated so that the whole may look respectable.

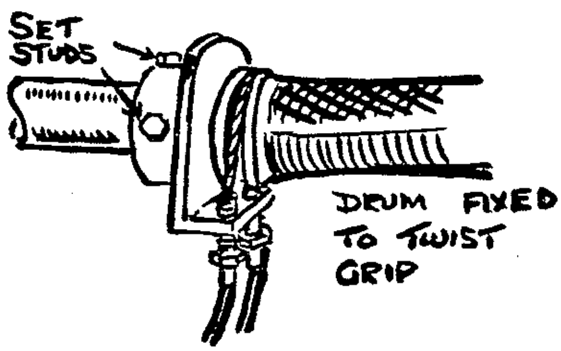
All these alterations to the two-speed gear have revived another idea, long cherished but so far not carried out—positive location for top and bottom gear with a handlebar controlled locator for neutral. The friction grip was always a bit of a nuisance in traffic if one wished to get into neutral in a hurry. This alteration is already more than half carried out, but a description of it must wait until at least it has been put into operation.

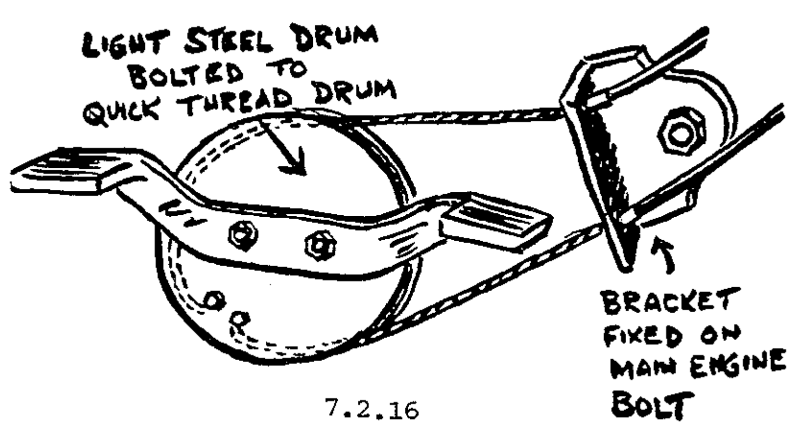
TWO-SPEEDER CONVERSION UNITS V i1/10 June 1980

G. E. Bowden of Dorset would like to have published "Wharfdales" or Titch Allen's conversion of the two speed gear to hand clutch, as he cannot recall this useful piece of information, so suitable to modern traffic conditions, having been published.

We'll try to have this in our next issue — in the mean-time here's an idea, which has certain advantages, in that it does not in any way interfere with the oiling to the gear unit.

The idea was supplied by O. L. Bowness, of Brigg, South Humberside and was culled from a "Motor Cycle" of yesteryear. It appeared in their Correspondence column under the heading "FOR SCOTT OWNERS."





W.C. FOX RIDES AGAIN

Jack Frazer

Having been foolish enough to draw attention to W.C. Fox's two- speed gear modification, it became borne in upon me that I had little option but to set to and endeavour to produce the same result myself.

I therefore re-read Fox's instructions as given in *Yowl* Vol. 4 No. 1, only to find that what at first sight appeared a straightforward matter, was in fact the very opposite and that it was likely to provide quite a few problems before a satisfactory solution could be achieved; this indeed proved to be the case.

It would be tedious to give a blow-by-blow account of the various trials and tribulations encountered and I shall instead give some notes on various aspects of the conversion and sketches showing principal dimensions of the components which I made to do the job; these should be read in conjunction with Fox's original description.

First, the Notes:-

1. How does it work? Not entirely clear from the original description (pity there were no drawings), but what in effect is implied is that, when low gear is engaged by pedal, a spring advances and bears upon the end of the gear push-rod and is of sufficient power, when partially compressed, to engage that gear. This can be opposed by the new push-rod operating on the other end of the gear push-rod and connected by leverage and Bowden wire to the hand control to such an extent that the pressure of the spring is relieved with consequent disengagement of the gear. Thus the hand lever in effect becomes a 'clutch' in the accepted sense of the word.

2. The Gear itself. No internal modification is necessary, *but* it must be in good order and capable of holding both low and high gears without slipping when engaged by pedal. I wasted a lot of time in trying to get results with a gear in which low did not engage properly; I eventually had to dismantle and make good (a replacement clutch ring) before any satisfaction was achieved.

3. Fox's modification to low-gear clutch ring. He recommends an alteration to the angle of entry in the gap of the ring. I did not carry this out as it would result in increased push-rod movement to engage low gear from the free position. Minimum push-rod movement is essential to keep leverage problems within bounds.

4. The Springs. Fox used a spring $1\frac{1}{8}$" long and $\frac{3}{4}$" o.d. with three or four turns of $\frac{1}{8}$" wire. I found this unnecessarily long and after trial ended up with one $\frac{7}{8}$" long by $\frac{3}{4}$" with four turns of $\frac{1}{8}$" wire. Fruitful sources of such springs are old Borg and Beck clutch plates which have a circumferential row of shock-absorbing springs inside the plate itself. Trial and error here to some extent.

5. The Spring Box. This is a straightforward piece of turnery. I made it in three parts as shown — flange, body and cap — brazing the flange onto the body with Easyflo; all made from offcuts of MS plate and round stock. The length dimension $1\frac{5}{8}$" is really too long, but I purposely made it so to accommodate various lengths of spring. With shorter springs, make up with internal distance pieces ($\frac{3}{4}$" o.d. aluminium rod) to desired length. When all is to your satisfaction you can shorten box and/or cap and discard the distance pieces.

6. The Interface — Spring/Push-rod. You must interpose between the spring and the shouldered 1/4" BSF nut on the end of the gear push-rod a short blank distance piece, say 3/4" long and 3/4" o.d. to prevent the bore of the spring riding up on the hexagon of the nut, thus creating misalignment.

7. The Pedal. Fox's directions for this are somewhat obscure. I show my interpretation on the sketch (omitting the actual 'touches' for the foot; in my case two Honda moped pillion footrests!). I attached the pedal to the spring box by four 2BA c/s screws, not rivets as suggested, to facilitate trial. When finalised, I think rivets would be better. The arcuate (!) slots which accept the two 1/4" BSF studs in the five-start drum sleeve, and which are duplicated in the flange of the spring box, permit relative angular movement between the drum sleeve and the pedal. With this additional facility it becomes possible to adjust the gear in the usual way with washers on the push-rod to give full gear engagement for both high and low (i.e. with the friction ramps on the drum fully engaged in both gears) and at the same time to set the pedal in optimum position for foot operation. This relative movement is not available with the usual pedal; you have to accept what you get.

8. The Five-start Sleeve. Centre hole must be bored out clearance on gear push-rod (7/16" plus .010") and, as Fox indicates, the large washer on the inside of the sleeve discarded. Thus the sleeve itself engages high gear only, and low gear is engaged by the spring and box attached to the sleeve.

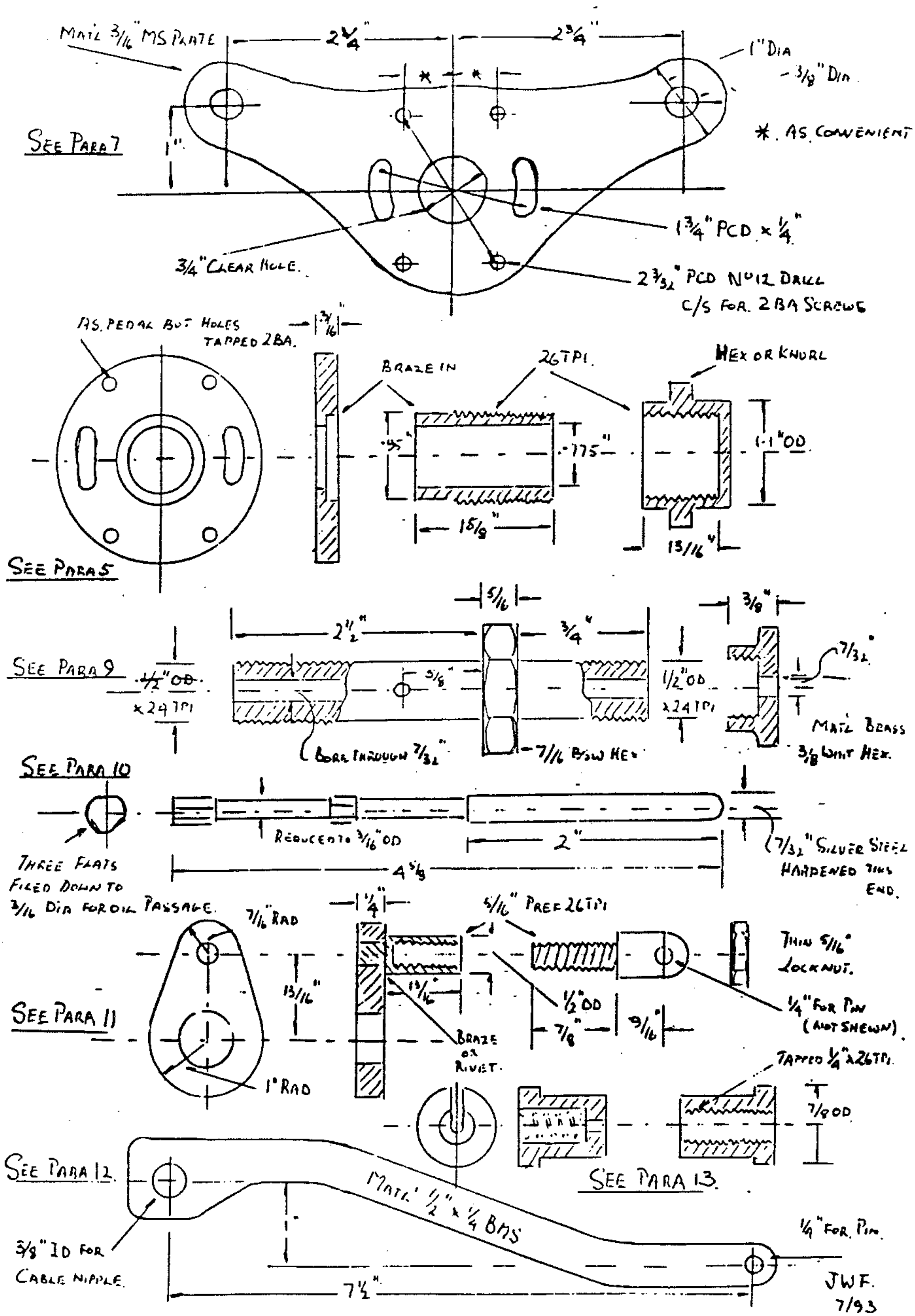
9. The replacement Set Bolt for near-side of gear. Again a simple turning job, but note that dimensions shown as 3/4" on the outer end of the bolt can be reduced to 1/4". The additional length is required on my machine to accept the eye of a R and L hand bottle screw adjuster, which links the gear to the crankcase stud carrying the crankcase door supporting strong back to prevent the gear slipping on the frame rails.

10. The new Push-rod. I give the length dimension as discovered by trial; probably best to do the same in view of variations between individual gears and machines. With low gear fully engaged by pedal the push-rod should project beyond the gland nut by about 5/32". Make sure that the push-rod has the necessary reliefs in diameter to allow oil to pass on to the heart of the gear.

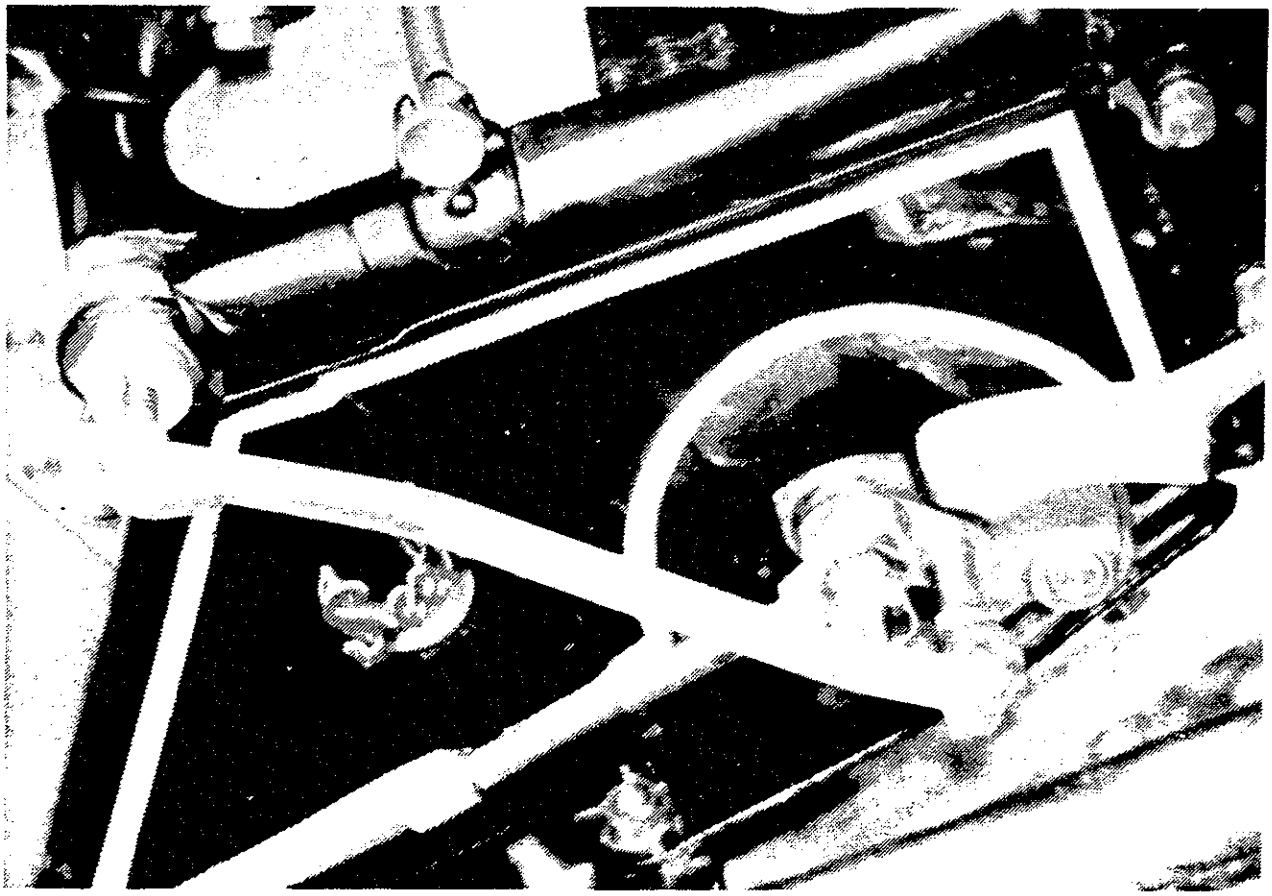
11. The Fulcrum for the Lever. Fox suggests the use of 3/16" plate as a base. I found that this flexed under load, so substituted 1/4"". Furthermore, I made the yoke adjustable for height as shown. This is worth doing as it provides an additional joint for fine tuning of the leverage. Note that the plate must be 'fitted' by filing on one side just below the yoke pillar to ensure that it pulls up square on the gear lug, which is not a machined surface at this point. Exactly where the fitting is required is determined by the angle at which the lever is fitted and this in turn depends upon where you decide to position the pull of the Bowden cable. Note also that if you reduce the length of the outer end of the set bolt (as in 9.) you will have to make a corresponding reduction in the height of the pillar and yoke above the base plate. The effect of this on the leverage would have to be thought through.

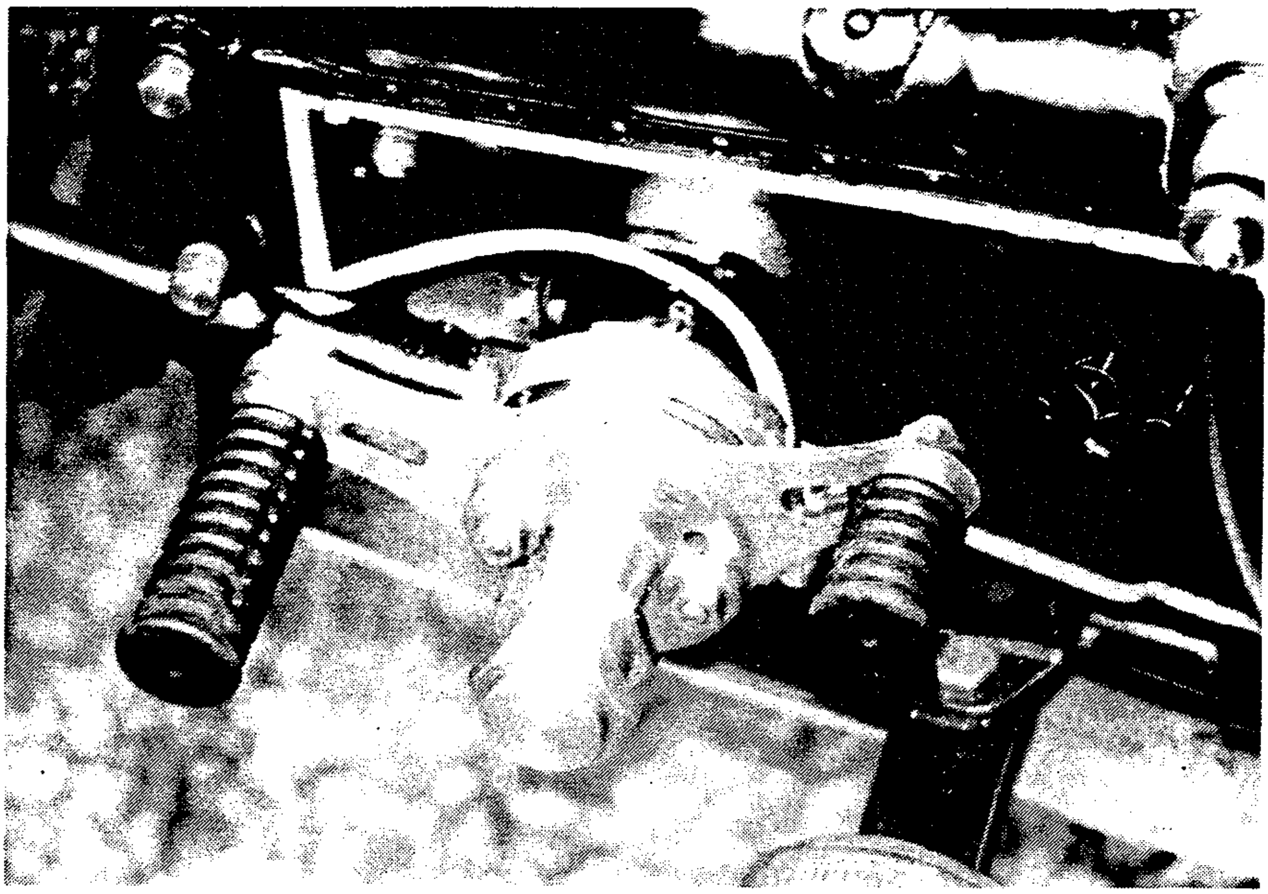
12. The Lever. This was sawn out of a length of 1" x 1/4" BMS and subsequently bent cold to shape. The bass to accommodate the 3/8" o.d. barrel nipple for the inner wire was built up by brazing an additional piece of 1/4" steel onto the side and formed by drilling and filing. To get

(cont. on p229).



Drawings (not to scale) for Jack Frazer's modifications.





the hole and the slots for the wire is quite tricky and involves some fiddly filing and drilling.

13. The abutment for the Bowden wire etc. I couldn't adopt Fox's method as my magneto got in the way. After a lot of cogitation I decided to reverse the lever to point forwards rather than backwards and to pull it via a clear sight-line through the two hollow engine bolts. 'Stoppers', a push fit in the bores of the engine bolts and slotted to go on the inner wire, were turned up from alloy bar and one fitted with a screw outer cable adjuster, the other chambered to accept the light return spring suggested by Fox.

This arrangement can be criticised in that it can only accommodate a limited movement of the gear itself for chain adjustment, but up to date this has not been a problem. The entry run of the Bowden cable is also somewhat vulnerable to damage by foot or otherwise. I have ideas to improve this, but for the moment enough is enough!

14. The Hand Lever. I was fortunate to find an old-time forged lever long enough to give the necessary leverage, but even this had to be bent outwards in an displeasing manner to provide sufficient movement. Movement rather than leverage appears to be the crucial factor. In use the 'clutch' is no more difficult to operate than a conventional one.

15. The Sketches. These are NOT to scale. The measurements were all checked before the final (and umpteenth!) assembly on the machine, but I would emphasise that they are for guidance only. Individual gears and machines vary and it would be prudent for anyone making the components to check each before putting in hand. I apologise for the contorted layout of the drawings, but it was not easy to persuade them all on to one sheet of A3.

16. The Photographs. These show on the offside the new pedal and spring box and, at the top right hand corner, the entry of the Bowden cable feeding through the hollow engine bolt. On the nearside can be seen the fulcrum point, the lever and push-rod, and the exit end of the Bowden cable. It may appear that all this junk gets in the way of the brake pedal, but I have found little difficulty with it.

17. The Final Result. Up to date, most promising. Once one has got accustomed to the idea of a hand-operated engagement of low gear, and to the greater sensitivity it confers, traffic light, roundabout, stop and start on hill problems all become things of the past.

Is it worth the effort? Yes, provided your gear itself is in sufficiently good condition to make it work correctly.

THE SCOTT TWO-SPEED GEAR

A Thesis by Ernie Scott

Robert Rawlins writes: At a London meeting some months ago a group of old greyheads were solemnly discussing the simplicity and longevity of the two-speed gear and how the smooth running had been advanced and its life extended by the use of the bracelet bearing broached out to take $\frac{3}{16}$ inch rollers in place of $\frac{3}{16}$ inch balls as produced by our much-revered Tom Ward, and the replacement of the thrust bearing by the EW7/8 caged bearing as advised by George Reeves and Mr. Fox. To our surprise, Ernie Scott, of Emporium fame, then volunteered the information that he had made some experiments of his own which he then described in detail and said he would show us the following month. The following month arrived and what we saw convinced us that the two-speeder had been given a further long span of smooth and active life. Ernie promised detailed notes of his work but before passing you over to Ernie I would like to ask if any enthusiast has ever considered inserting into the oil pipeline from the tank to the gear a device such as a carburettor jet which would permit a continuously controlled flow of oil to the gear when the tap is opened.

Now here follow notes of Ernie's work.

Notes on modifications to the Scott two-speed gear.

For some time I have studied the remains of a two-speed gear in my 'spares box'. It was in a very sorry state and was unusable in that condition. I therefore decided to try to reclaim the gear, updating, where possible, bearing surfaces, etc. The bulk of the wear was of course on the centre hubs where the bracelet bearings run — the inevitable tracking. This hub had tracked very badly, probably to depth of 3 or 4 thou, and so had the thrust races which normally contain a collection of $^{9}/_{32}$ inch balls and a retaining ring, and of course the cups and cones were also well worn — these however did not prove quite as difficult to find at various autojumbles.

Reading through back numbers of *Yowl* I found a couple of articles by Mr. Fox and George Reeves on modifications to the two-speed gear, and the more I read them the more sense it was making — the stumbling block was still the bracelet bearings. Some careful measuring was done and the problem was taken to my friendly bearing merchant. He was, of course, somewhat surprised to know that bracelet bearings were still in use in these gears, and said: "Caged roller races". A search through his records and suppliers' books produced a needle roller bearing tolerably close to the sizes I had taken in. They were, I think NK 47/20 type. A pair of these were ordered and in due course arrived. In the meantime I had discussed my proposed mods with people more knowledgeable than me, engineering-wise and two-speeder-wise. Both schools of experts came to the same conclusion — they didn't see why not. Anyway, I had nothing to lose; the gear could not be used as it was, and that was for sure.

The new needle roller races proved to be slightly undersized when fitting them into the gear wheels and also undersized to go onto the hub — this was not overmuch a problem as I rather wanted to grind out the score marks on the hub. A shim ring about 2 thou thick was all that was needed to make these bearings a press fit into the gear wheels, and as the depth of these bearings was just under the depth of the old brass bracelet bearings, fairly careful fitting was required to centralise the new bearings in the gear wheels. Careful and tedious grinding of the hub removed the score marks and eventually produced an easy-running fit for the roller races. Most bits of the two-speed gear seem to hard right through, which was useful. So far so good.

The thrust races were renewed by another proprietory bearing consisting of two hardened rings and a set of balls contained in a steel or brass carrier — so to get the correct, as-original, thickness with good flat running surfaces was reasonably simple.

This modification is part of a series of mods in Mr. Fox's articles. Before re-assembly the other mods recommended by Mr. Fox were undertaken: oil holes in the hollow spindle, cutting oil-carrying grooves in the centre solid spindle, marking the end of the centre spindle to ensure that the gear/spindle assembly is the right way up when installed in the frame, etc — you read them up!

On completion I was pleasantly surprised to find a nice easy action of the gear with gear engagement by hand pressure on the end of the shaft and smooth wobble-free running otherwise.

The other modification was to change the low gear wheel to one of 42 teeth as suggested by a Mr. Rhodes sometime back as being the theoretically correct size to give even tension on both chains and gear alignment correct in the frame.

The completed gear was passed around the previously-mentioned 'school of experts' who were very kind and seemingly impressed. Now all that remains is to try it out under real conditions.

V15/5 Aug. 1987

SPOT-ON TWO-SPEEDER CHAIN ADJUSTMENT

G. R. Reeves

Recently I had to dismantle my two-speed gear to fit a new bearing. When I looked at the two gear lugs I thought I would devise a once-and-for-all method of getting accurate alignment without using the angular measurement suggested in the Book of the Scott. This is what came up: a length of mild steel ⅝" long. The ends were turned down to ½" diameter at one end (to stick though the hollow bolt hole about ½"), the other end to stick out about ½" beyond the slot in the gear pedal side lug. The ⅝" diameter of course sits in the slots in the lug. Now measure from the door strap stud to the ½" diameter each side — I used a vernier calliper gauge, but you could use a rule. When both measurements are equal, tighten lug and re-check.

Now measure from edge of lug along the frame about ½", and scribe a line; do this on both sides. You now have two reference points, one on each side. When adjusting chains, provided the distance from scribed line to edge of lug is equal on both sides, you will retain the alignment.

THE EARLY SCOTT TWO-SPEED GEAR (UP TO 1912)

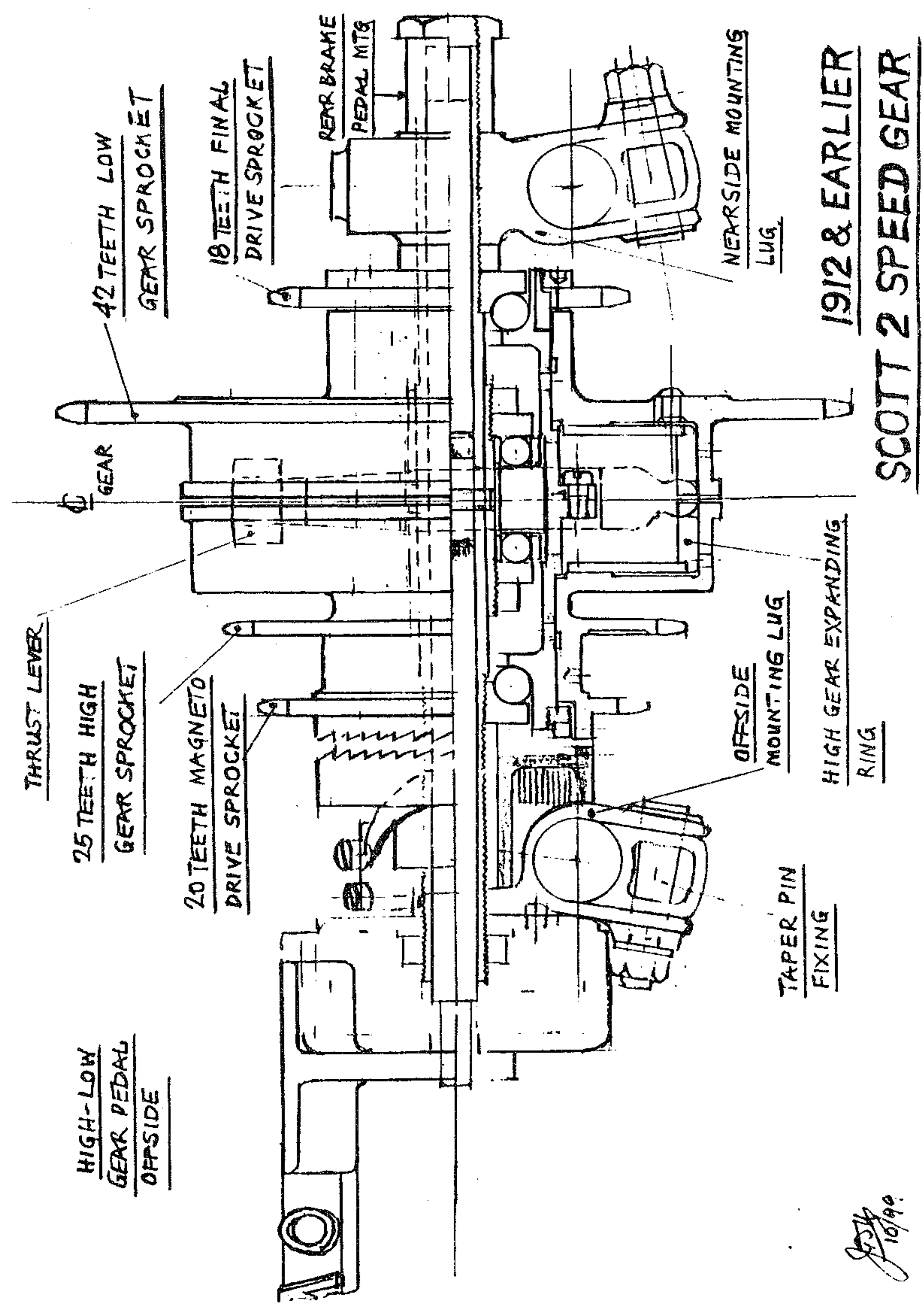
This article would not have been possible without the loan of a nearly complete gear by Graham Gardiner, to whom my grateful thanks are extended. Since some parts of the gear were missing I made some assumptions in the description, and would therefore be pleased if more knowledgeable members would come forward and make any corrections necessary.

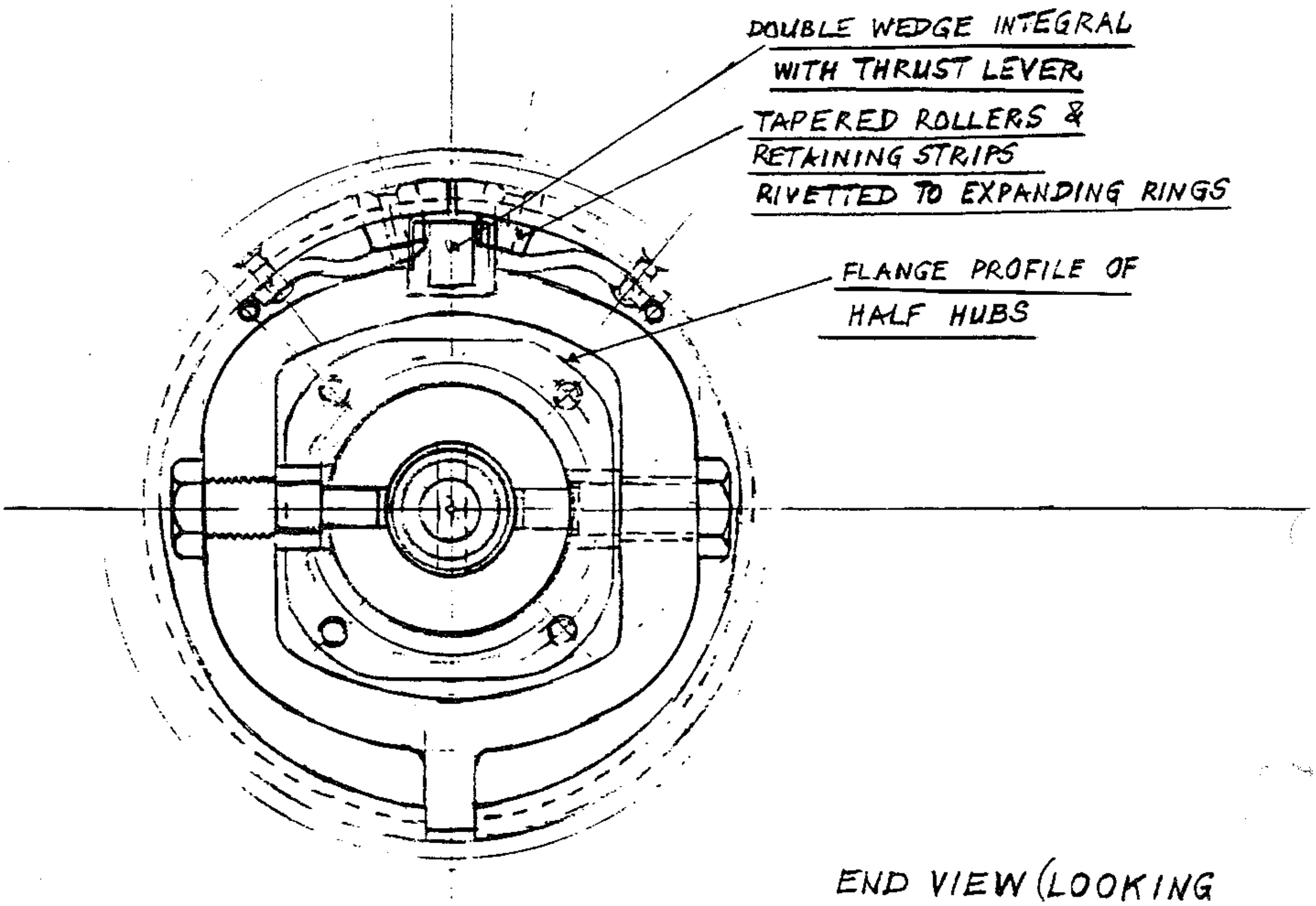
In describing the construction and operation of the gear it will be helpful to study the cross-section and end view drawings which I have prepared.

The operation of the early two-speed gear was identical to the later pattern, but the construction was completely different. The gear was mounted on two lugs similar to later ones, but clamped to the frame by tapered pins and nuts, which arrangement was not entirely satisfactory to secure the gear rigidly to the frame and maintain correct chain tension.

The drive to the gear was, as in later models, by two $^{1}/_{2}$" x $^{3}/_{16}$" chains and sprockets at 2" centres on either side of the engine's central flywheel. The 20 tooth sprockets adjacent to the flywheel drove a 42 tooth sprocket on the near (LH) side to provide low gear, and a 25 tooth sprocket on the off (RH) side to provide high gear. Adjacent to the high gear sprocket was a 20 tooth sprocket to drive the magneto by $^{1}/_{2}$" x $^{1}/_{8}$" chain. A range of final drive sprockets was available, but on this particular gear an 18 tooth sprocket was fitted to the centre hub, being located on a plain diameter, and driven by a single special stepped key and retained by a ring nut having three key holes.

The centre hub was made in two halves with central flanges spigotted together and secured by four $^{3}/_{16}$" BSF slotted head screws. The centre hub halves were made of hardened and ground steel to provide plain bearings for the high and low gear drums, the bearing surfaces being drilled and grooved for lubrication purposes. The centre hub assembly revolved on adjustable cone bearings each having nine $^{5}/_{16}$" diameter ball bearings, but the cup bearing surfaces were integral with the centre hub assembly with no separate cups, as in later versions, which had $^{9}/_{32}$" diameter balls throughout. There were also certain dimensional differences in the centre hubs in the early years. The high and low gear sprocket drums revolved independently of each other and were also made of hardened and ground steel with grooves for lubrication of the plain bearing bores. Whilst the low gear drum incorporated a rivetted sprocket assembly, it is thought that the high gear drum and sprockets were made in one piece. The expanding rings, instead of having tapered open ends, as in later types, were arranged with two tapered rollers and retaining strips rivetted in position, whilst the backplates had two pins for radial positioning of the rectangular apertures for the operational clearance of the thrust lever. The expanding rings were expanded by a yoke-type thrust lever pivotting at one end, but rollers were not employed in later years; instead a shaped double wedge integral with the yoke was employed. The thrust lever operated a $^{3}/_{16}$" diameter cross-pin sliding in a slot in the gear hollow spindle and coupled to the central thrust rod, moving sideways with operation by foot gear pedal, and five-start quick thread male inner and female outer scroll. The yoke was attached to the centre hub and thrust block by means of thrust lever screws and square blocks sliding axially in slots in the hub. The


1912 & EARLIER
SCOTT 2 SPEED GEAR
42 TEETH LOW GEAR SPROCKET
18 TEETH FINAL DRIVE SPROCKET
REAR BRAKE PEDAL MTG
NEARSIDE MOUNTING LUG
℄ GEAR
THRUST LEVER
25 TEETH HIGH GEAR SPROCKET
20 TEETH MAGNETO DRIVE SPROCKET
OFFSIDE MOUNTING LUG
HIGH GEAR EXPANDING RING
TAPER PIN FIXING
HIGH-LOW GEAR PEDAL OFFSIDE



central thrust arrangements comprised an outer sleeve threaded at both ends, centre thrust block, bronze cages, both with ten 1/4" diameter balls arranged in two concentric pitch circle diameters, hardened thrust washers with threaded bores and locknuts on either side of the thrust block.

Very few parts were interchangeable with the later gears; the main hollow spindle and the complete thrust assembly was smaller in diameter; the kickstarter ratchet and ratchet ring were also smaller, having 17 ratchet teeth compared with 18 teeth on the later gears.

The gear was lubricated by means of a 'Flip-Flap' type lubricator screwed into the top of the nearside gear mounting lug, being periodically filled up from the oil gun usually carried on veteran Scotts. It is believed that 1910 and earlier machines had an open trough integral with the LH gear lug.

John Underhill.