7.3 Three-Speed Gearbox and Gearchange

MACHINING A MOTOR CYCLE THREE SPEED GEAR CASE

The methods employed at the Works of the Scott Motor Cycle Co. Ltd., Saltaire Works, Yorks.

(From *Machinery* of August 5th 1926).

The Scott Motor Cycle Co. Ltd., Saltaire, Yorks, supply their motor cycles with either two or three-speed gear boxes. The latter, an inovation, was primarily designed for use in a combination with a sidecar, but is now fitted extensively to both solo and combination machines.

The three speed gear and clutch are shown in Fig. 1. All three gears are brought into action by one sliding dog, and the gear wheels are always in mesh. In Fig. 1, when the second or middle gear is brought into engagement, the drive in this case is transmitted through the clutch and wheel C to the lay shaft and back to wheel B. The dog clutch on B engages with the sliding dog D on the main shaft to which is attached the driving sprocket. The first speed or low gear is engaged by moving the sliding dog D so that it engages with the dog on wheel A. The neutral position is when D is between A and B or B and C (see drawing) but for convenience the lever is arranged so that only one neutral gear is normally used— that is, between A and B. A high gear is obtained by engaging sliding dog D with the dog on wheel C. The wheel C and the main shaft are then locked together and run as one, all other wheels running idle. The dogs and wheels are made of 3% nickel chrome steel and hardened, in order to have ample strength to withstand the various shocks to which it is possible to subject them.

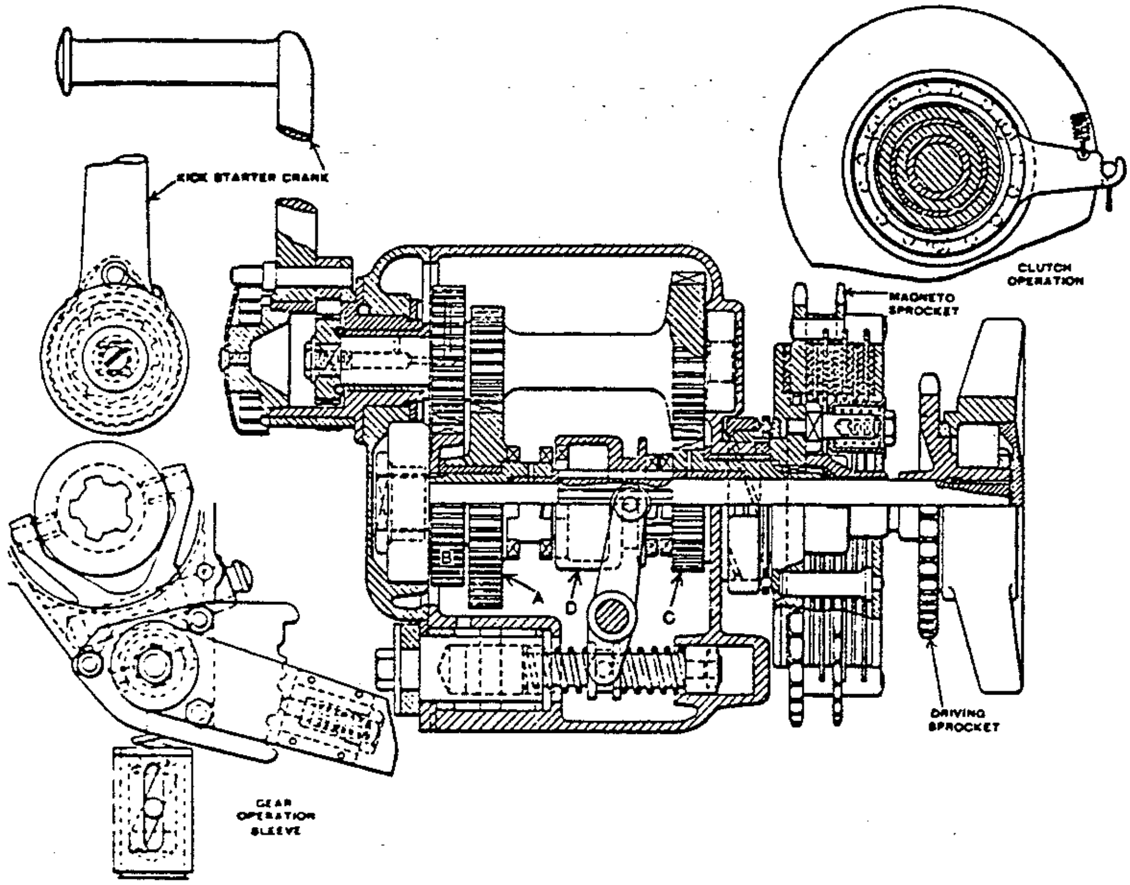
The clutch is of the dry multi-plate type, having floating friction linings between steel plates, alternate plates transmitting the drive to those between them. The clutch can be operated by very small pressure upon the handlebar lever, the spring pressure on the plates being very light. The whole of the clutch can be withdrawn from the frame without disturbing the gearbox, it being only necessary to detach the chains and the driving sprocket bracket, when the six hexagon-head screws that carry the clutch springs may be removed.

The engine and the gear box are mounted on an aluminium tray as a separate unit before being assembled in the cycle frame, to which the unit is attached by six bolts. The gears are lubricated by filling the box with oil through the inspection lid orifice on the top of the box. It is impossible to move the engine chain out of alignment when making chain adjustments, as the box slides along guide rails on the aluminium tray and is secured by two bolts. The magneto chain is adjusted by slackening its base nuts and sliding the magneto backwards or forwards upon its seating on the gear case. The ratio of the final drive can be easily altered (thus affecting each gear) by changing the driving sprocket for another with more or fewer teeth.

GEAR CASE COVER

The various operations on the gear case cover and the gear box case will now be taken in sequence, together with a description of the fixtures and jigs employed for these operations. The gear case and the cover are both aluminium castings. The first operation on this is to grind the rough face on emery discs, the time taken being eight minutes.

In the second operation, the 1⅝ in. diameter hole is bored, the inside of the hole being faced, and the bolt hole bosses and other outside facings are machined. These operations are performed on a No. 4 Herbert Capstan lathe; single point tools are employed, these being held in the square turret. The 1⅝ in. diameter hole is bored out and the inside face machined by a cranked tool with a right-angled cutting edge. In the second



The Scott three speed gear box and clutch (Super variety). (Illustration by courtesy of Machinery).

operation, the locating spigot is omitted, and the gear case cover is arranged reverse hand to that for the third operation.

In the third operation, which is also performed on a No. 4 Herbert Capstan lathe, the 2½ in. diameter blind hole is machined and the face turned. The cover is located from the spigot mounted in the 1⅞ in. diameter hole already bored. The gear case cover is pushed up against the position plate and secured by the adjustable clamping plate which moves in a slot. Both the position and clamping plates are shaped to suit the cover. The blind hole is bored, the bottom faced by a form tool and reamed, the tools for this operation being mounted in the hexagon turret, whilst the turning tools for the face are carried in the square turret. The boring and facing operations take 38 minutes.

In the fourth operation, all the holes in the cover are drilled and reamed at one setting of the work in the jig. The drilling is carried out on a Jones and Shipman vertical machine, using a jig when drilling. It is located from the 1⅞ in. diameter hole by the spigot, positioned by a spigot in the 2½ in. diameter blind hole, and secured by a clamp nut. The time taken for drilling is 22 minutes.

MACHINING THE GEAR CASE

The first operation on the gear case is to level the rough face on the abrasive discs, the time taken being seven minutes.

In the second operation, the 1½ in. diameter hole is bored, and the boss turned and the inside face machined. The tools employed for this operation are similar to those used in the second operation of the gear case cover, and the machining is performed on a No. 4 Herbert capstan lathe.

The third operation is also carried out on a Herbert No. 4 capstan lathe. In this operation the 1 and 9/16 in. diameter blind hole is bored and the face of the gear case turned. The gear case is located by the 1½ in. diameter hole already bored and positioned by a suitably shaped plate. A special clamp plate enables the case to be securely held. A double spade cutter is used for roughing out the blind hole and a single point tool for finishing before reaming. These tools are carried on the hexagon turret. The single point tools for turning the gear case face are carried in the tool rest. These second and third operations are done in 42 minutes.

The fourth operation consists of boring out the 1¼ in. and ¾ in. diameter holes. The exact positioning of these holes in relation to the 1½ in. and 1 and 3/16 in. holes previously bored is very important. The fixture used for this operation comprises a base plate with a long spigot for the 1½ in. hole, on top of which is mounted a link plate which carries a spigot to fit the 1 and 3/16 in. blind hole. The first spigot is fitted with a key, and a key-way in the link plate boss ensures correct location of the second spigot with the 1 and 3/16 in.diameter hole, and of the case for the 1¼ and ¾ in. holes to be bored. For this operation which takes 15 minutes, the boring tools are mounted in the capstan rest of a 10 in. centre Parkinson capstan lathe.

All the holes are drilled and tapped in the face of the case as a fifth operation in 12 minutes. The jig for holding the gear case is located by the 1½ in. and 1 3/16 in. holes by spigots and secured by a clamp nut. The drilling operations are carried out on Jones & Shipman vertical drilling machines. For tapping the screw holes, a Pawson tapper is employed, the top plate of the jig being, of course, removed during this operation.

The sixth, seventh, eighth and ninth operations are carried out on a Parkinson No. 4 horizontal milling machine in 28 minutes. In the sixth operation the boss is straddle milled. An angle-plate fixture is employed for securing to the milling machine table and location is made by a spigot in the 1½ in. diameter hole and a pin in one of the dowel pin holes in the face of the gear case, the whole being secured by clamp plates.

The seventh operation consists of milling and facing the inspection hole. The same fixture is used as in the previous operation, but this is mounted at right angles to that required for the sixth operation.

In the eighth operation, the seating is milled. Location is by suitable spigots in the 1½ in. and 1 3/16 in. diameter holes, the spigots being arranged on an angle plate fixture. The clamps are held in place by long studs and securing bolts upon which are placed long coil springs.

(The times shown refer to the boring, drilling and facing operations only, and do not take into account the time spent on fitting up the covers and cases, or the tools for the various stages. The total times given above are about 3 hours—just for the gear box casings! This should explain why Matt can only turn out Scotts when time and other matters allow).

THE SCOTT THREE-SPEED GEARBOX

A partial explanation of the alternative combinations of ratios available, including some originally unintended notes on the various boxes installed in the 3/speed Supers.

by *Geoff Lee*

Initially it should be made clear that this survey was confined right from its inception to a study of the gear sets, i.e. internal "cluster" arrangements fitted to what can best be termed the usual Scott gearbox. This is used to the present day and was introduced in 1926 with the new 3/speed "Flyer" duplex-frame machine. Various internal and external modifications have been made since that date, some of which will be commented upon but few are of profound significance.

I've had little experience of the 2/speed machine but understand that both "close" and "wide" alternative ratios were available as well as a selection of driving sprockets (19-22 teeth) the recommended system being merely to change to a 75 tooth rear-wheel sprocket (in place of a 66) when using the machine for sidecar work.

The "nigger in the woodpile" however, for want of a better term, is undoubtedly the notorious 3/speed Super in concurrent production in the late vintage period with the "Flyer" type non-open-frame machine. This is not a Scott I've ever had any ambition to own although it has been described as combining the better features of the 2/speeder—lightweight and handling and the duplex-frame models—the extra "speed" provided by the newly introduced gearbox. The model certainly has its devotees. The fact is, during its short production run 1923-28 no less than three different gearboxes were fitted. The first arrangement offered was, I'm told, designed by a man named Shackleton and was not all satisfactory. So much so, that a revised design was offered in 1926 after a lapse in production. This alternative arrangement had a larger clutch necessitating a new undertray also (which of course tied the front and rear sections of the frame together and provided the engine mountings also. It differed radically from the earlier box, the low and second gear pairs now being in the usual position and the clutch no longer being operated through the mainshaft. Even a new design outrigger bracket was required. The magneto was now carried on a separate platform instead of as before being bolted directly to a machined surface on the "roof" of the box.

As I said, these boxes were not intended to be included in this summary but in order to avoid confusion I can perhaps add that on the '25 and earlier gearbox each pair of gears should sum to 56 teeth and on the later model to 52 teeth. These gear-sets are of course readily identified by their much finer pitch teeth. So unsatisfactory was the first example that Scotts, I've heard, offered the conversion assembly free of charge (exchange) to owners of the machines thus equipped and they are now, of course, an extremely rare bird. (Cyril Wright has or *had* one—he's recently agreed to let us know, as soon as he is able just the full extent of his Scott collection and, I hope, the brief history of some of the machines). The rear chain of these 3/speed Supers was of a lighter pattern (5/16 ins. x ½ ins.) i.e. the same as the conventional primary chain and similarly, of course, the alternative outrigger sprockets, which were incidentally offered in 23-27 teeth forms. Both these boxes are readily identifiable and were originally fitted with the long "walking stick" non-positive stop handchange control.

In 1928 the overlap period was reached and for one year only, the last 3 speed Super production year, the machine was again re-designed mildly to accept the conventional gearbox shell and (presumably) internals, mated to the existing clutch. I say "presumably" here, as it's a fact that the internals from the "intermediate" Super box were interchangeable with those of the conventional box—to this point I shall return. The gearchange arrangement incorporated for '28 was a "Flyer" type gate and linkage hung from the centre single downtube, a scheme perpetuated with the Sprint Special for the subsequent two years. Machines of this type are owned by Reg. Summers and Arthur King of Luton. There may be some positive identification to distinguish these boxes from those fitted to the "Flyers" but I'm not aware of it. Perhaps either could tell us and confirm about the internals also.

To get back to our standard gearbox then, I must refer you to the chart showing the four conventional basic variations and identified A, B, C & D for convenience. At first sight this appears perfectly straightforward but I believe it is worth taking each combination in turn and probing a little deeper. I should explain, having referred to the chart, that I have calculated all ratios (in order that a direct comparison can be made) considering a 19T final drive rear sprocket (minor discrepancies with B. of the S. figures are of no consequence). The other factors, outside the box, are, I'm pretty sure, standard for all machines, certainly those for clutch and engine sprockets are and any variation in rear wheel sprocket size is usually confined to hybrids with "converted" Enfield type components. With Scotts, though, you can never be 100% sure and I should welcome clarification on this point.

TYPE A.

This is generally referred to as the "Vintage" or early wide set. The teeth on the lay and mainshafts are as shown and this type were fitted, according to the Book of the Scott up till gearbox No. 3194. The year 1934 is inferred and Tom Ward informs July of that year. There's certainly no mention of the later wide set alternative mentioned in my 1932 edition which is the nearest I've got. Throughout this period the early close set (B) was offered as an option but taking 1929 as an example (Scotts best production year) two of the 3/speed machines included the "wide" set in their specification, only the Replica being quoted with the close box. There is little doubt that the vast majority of gear sets to this early wide pattern had the "solid" (machined from one billet) lay shaft. However I'm told that some assemblies were produced at a later date as spares for the earlier machines comprising the original wide ratios (i.e. the lower 2nd gear) fitted to the, by then, standard layshaft unit and supplied in "built up" form. This may have applied to the early close set also. I should be interested to hear if anyone has internals to these patterns. For identification purposes I should add that with the wide gears originally fitted the box was, of course, stamped W and usually at least one of the gears was also, often the high gear meshing wheel on the layshaft.

TYPE B.

This is the "Vintage" or early close box, often rather confusingly referred to as the Ultra-Close box, naturally inferring at least two other degrees of closeness! This may have evolved to distinguish it from the later close set, although this is generally referred to as the Medium Close box. I suspect it was a bit of crafty advertising, "Ultra Close" sounds so much more exciting—rather like the Flyer rear chain guard which has always been "extra deep." As shown in the chart, none of the gears used in the close box were utilised in the wide version and this undoubtedly made for expensive production. This was one of the major factors which influenced the change over to the re-designed sets, both of which employed a 25T High Gear wheel (as in the early wide set). These close gears were used in all the racing Scotts and T.T. machines although in these instances they were machined from K.E. 24D. (85 ton steel) enabling them to be undercut behind the teeth and for the shafts to be made hollow. Although the later close box was available in 1932 (possibly earlier) certain models were still fitted with the Ultra Close gears, particularly the more sporting and not too heavy machinery. These gears can be easily identified firstly by their relative diameters; at least one gear, often more, is marked "C" as was the box end-plate and again, of course, they are invariably solid layshaft produced.

TYPE C.

The Medium Close or Modern Close set is something of an enigma. For a start, this combination was in fact available well before the discontinuation of the early wide set. A quantity of these Medium Close ratios were produced in solid layshaft form and even as early as 1932 they were listed as the "Close" alternative. Later on production was standardised on the built-up type of layshaft. Various theories have been advanced as to why, one being that a special and valuable machine was used for the solid shaft hobbing (an examination of the early wide shaft with adjacent 19 and 14 tooth wheels will make this point clear). This, it is said, was sold during a period of financial embarrassment. The more likely explanation is, I think however, that the change allowed a standard bare layshaft to be utilised and in the event of gear trouble, only the offending component, not the complete shaft, required replacement.

I get the impression and have a private theory that the Scott Works were aware of some dissatisfaction by owners of Ultra Close equipped machines, probably having difficulty pulling away from rest with the very high 1st gear and/or clutch trouble, especially when such a bike might be using a 20 or 21 sprocket to ensure a high cruising, but not "screaming," speed ! In spite of the fact that four new wheels were fitted the designer ensured that 2nd remained constant (almost) at 6.12 or so. Bottom gear also could have been maintained at 8.13 (even with the change in high gear wheel and its mate) simply by using similar 19 and 24 wheels on layshaft and mainshaft respectively, as employed in the original Wide box, but for 2nd gear ! If the supply of these Ultra Close gears dries up it might be worth remembering this "fiddle" at some future date. Another point worthy of mention with regard to the "C.M." box, is that at some stage in the production of the actual shells to be later fitted with these gear sets, one of the internal boring operations was omitted. This consisted of a light skim out on the R/H "open" side of the casing sufficiently deep to accommodate the large 29T low gear wheel of the wide set. Thus it is necessary when making a conversion to either of the wide gear sets for this extra material (not a great deal admittedly) to be removed, as far as I remember from the forward and bottom faces of the box by filing, scraping etc. (Boxes affected in this way could be just the foot change variety, I'm not sure).

TYPE D.

This combination is, of course, the final one of the four basic alternatives. It differs as the chart shows, from the vintage or earlier version in respect of the quite appreciably higher 2nd (middle) gear ratio, which matter has already been covered. I can find no evidence to suggest that gear sets of this type have ever been supplied with other than the built-up layshaft. It is perhaps relevant here to emphasise a point Harry Langman made, and has probably occurred to the reader. On early gearboxes change of ratios was quite a big job necessitating the removal of the clutch and a complete strip out of the box. By standardising with the new arrangement on a high gear wheel of 18teeth the operation was simplified enormously, particularly as the gears themselves could be demounted from the layshaft in-situ. It was necessary then merely to remove the gearbox end cover, slide off the 1st and 2nd gear pair from the mainshaft and their companions from the layshaft splines, removing the lock nut, of course.

But to my mind it was the cost factor which was the primary consideration and the most appealing which led to the new scheme's adoption. There can be little doubt that a substantial economy was achieved.

Back now to the consideration of the "rogue" combinations which can be achieved. The first comes via Clive Waye (who incidentally reports that overall they consider type C, the Medium/Modern Close, the most suitable for vintage road racing, unlike most of the other racers who seem to favour the ultra-close set on their light-weight machines, pulling generally an exceptionally high gear). In his road bike Clive uses the internals from a '26 3/speed Super (gearbox No. 2 as referred to earlier). These are of finer pitch, of course, 25, 17 & 30T on layshaft, 27, 35 & 22 on main) giving 13.0 & 6.83 1st and 2nd ratios i.e. similar to the modern wide, but naturally a little weaker in construction I suppose.

A favourite amongst sprinters Derek Shire and John Hartshorne and possibly others is the combination of Medium-Close 1st and Modern-Wide 2nd (i.e. with 19T sprocket 9.84, 6.74 and 4.63 top). This modification is apparently perfectly straightforward. 21 driving 22 instead of vice-versa. It must be emphasised, however, particularly as the teeth numbers are identical, that the new pair must be obtained from the wide set. There can be no question of exchange from one shaft to t'other—this becomes obvious upon dismantling. I have an acquaintance who is of the opinion that Scotts were prepared to offer this particular combination on road-going machines and he has it fitted to his Flying Squirrel. He calls it the Close/Wide box, which figures. Finally Derek suggests I stress the point that box "bursting" can occur and in his experience is most likely to occur with this Close/Wide combination. He admits he can provide no explanation and it's my opinion that it's more likely a function of the power output the fast boys wring from the engine and who, of course, favour this arrangement.

I was in two minds whether to publicise this freak conversion particularly from the point of view of the up-and-coming Scott enthusiast of tomorrow. He's the one who's going to be fobbed off with the left-overs so to speak. A machine with the very low 1st gear then a tremendous jump to a close 2nd and top. I wonder, has any member any experience of riding with these ratios, with a chair perhaps ?

Whilst on this note of D.I.Y. combinations. If any of the early wide sets are available in B.U. form these could enable an additional but again rather pointless, assembly to be created. And to finish, on a discordant note, during my investigations for this article I came across a 1936 machine fitted with a conventional C.M. box *except* that for 2nd gear two 21T wheels were meshed (loosely !) to produce 6.43. It would appear that this was an error at manufacture (a 21 from a Close and another from a Wide set) as the machine had not been used a great deal. However, the end cover was missing, apparently appropriated by a well-known 2/stroke tuner and enthusiast, some of his other experiments still being in evidence. You never know with Scotts.

As I've hinted throughout this little report I consider it very much of "Interim" nature and I should like to know other member's experiences and queries regarding gearboxes and particularly their ratios. Perhaps I can then produce a sequel !

THE SCOTT THREE-SPEED GEARBOX—GEARS 10 D.P.

Summary Identification	*Layshaft Teeth Nos.*			*Usual Layshaft Construction*	*Main Cluster and High Gear Wheel Teeth Nos.*			*Gear Ratios with 19T Final Drive Sprocket* $\frac{44}{20} \times \frac{40}{19} \times 4.63$			*General Reference*	*Comments*
	2nd	1st					H.G.	1st	2nd	Top		
TYPE "A"	19	14	25	SOLID	24	29	18	13.32	8.13	4.63	"VINTAGE" or EARLY WIDE	Page 57, Book of the Scott ('30 and '31 Wide Ratio).
TYPE "B"	20	17	23	SOLID	23	26	20	8.14	6.12	,,	"VINTAGE" CLOSE or ULTRA CLOSE	Page 57, Book of the Scott ('30 and '31 Close Ratio)
TYPE "C"	22	17	25	BUILT-UP	21	26	18	9.84	6.15	,,	MEDIUM CLOSE	Page 58, Book of the Scott 1934 onwards ?
TYPE "D"	21	14	25	BUILT-UP	22	29	18	13.32	6.74	,,	MODERN (post '34) WIDE	Page 58, Book of the Scott (1934 onwards) after box No. 3194).

A MODIFIED GEAR-CHANGE

by M, N. Mavrogordato.

(Since Mavro's article "Oil Pump Saga," several vintage-minded members have written in to ask for details of his foot-change modification, which he proudly claims has given no trouble since he fitted it to his Scott more than 30 years ago. So here it is).

* * * *

In 1930 Messrs. Velocette published an announcement describing their Patent Foot Gear Change, and I was immediately interested. The announcement said: "The object of the Velocette patent foot gear change is to provide a safe, certain and simple means of changing gear without the necessity of removing a hand from the bars." It did just that, and I set about grafting one on my Scott.

Now to details:

The Velocette drum has been placed "back to front" but the lever A is moved round so that it still faces to the front. This lever is shortened, and filed so that gear pedal B does not touch it when changing up from 1st to 2nd. The small lever C is case-hardened at its extremity. The lengths a-b and c-d are important. When lever C is in middle gear notch, the lines c-d and a-b should be at right angles. to the line x-y, as indicated by dotted lines in sketch. The spindle D is turned from a piece of silver steel rod, and is longer than the standard Scott spindle, owing to presence of aluminium distance piece E.

The Scott "gate" is fixed to the base plate F by means of the two screws G which are threaded into the plate, their heads being suitably locked together by a single washer with flats on it.

With lever A and lever C in middle gear position, adjust the length of rod H till the clearance between the pawls and ratchet teeth is equal front and rear.

It is important, when changing from 1st to middle gear, or from third to middle gear, that the positioning on the Scott "gate" is *pulled* dead into the centre of the middle notch. This must be determined with the spring-loading spring removed. To obtain this desirably state of affairs, the Velo. drum must be completely dismantled and the slot in the main body of the device filed where marked in accompanying sketch, if necessary.

The ends of this slot, by coming up against stop peg. J, determine the extent of travel of the drum in either direction.

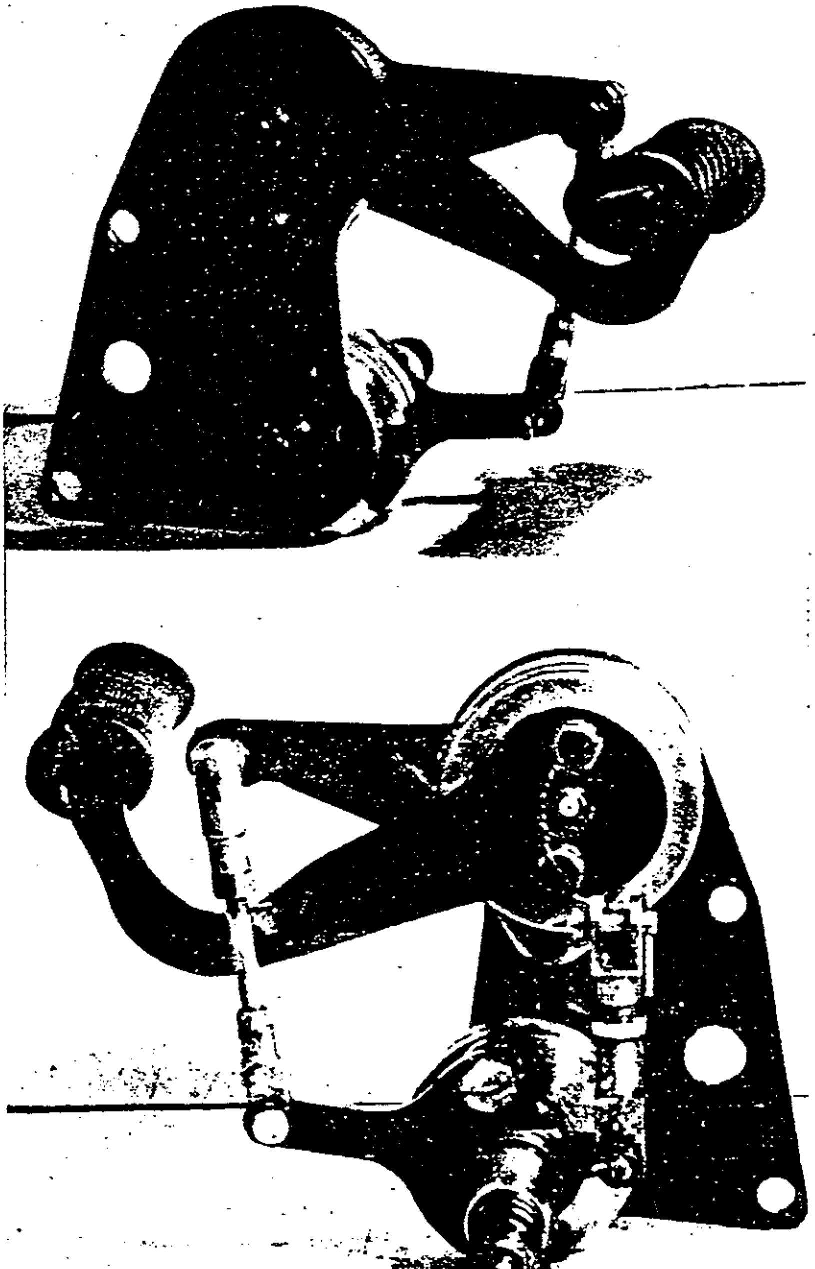
I think I can claim that this was the original of the Scott positive foot-change (Mavro still has letters dated 20/9/32 and 7/10/32 from Harry Langman of the Scott Motor Cycle Co., seeking details!) The Scott company brought it out in 1933 and I have always thought that it was an inferior copy of mine, for the following reasons:

1. It looked messy.

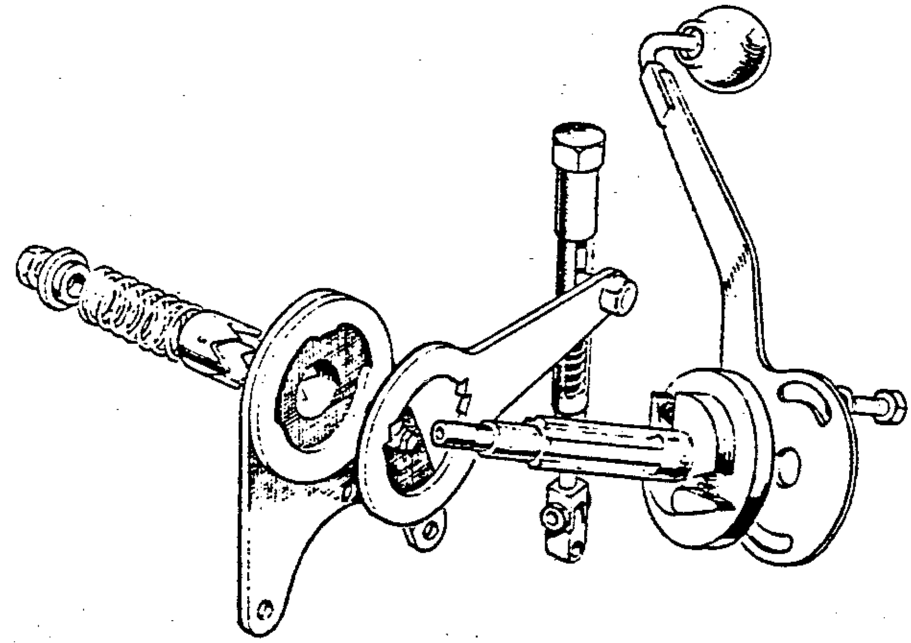
2. It has its gate-selector screwed to the front of the gear-box, which made it impossible to remove the whole device without taking the gearbox from the frame.

3. The gate/selector was itself far inferior to the Sturmey-Archer spring-loaded type.

I know from experience that the Scott version gave quite a lot of trouble—whereas I have never touched mine since the day I made it; and have *never* missed a gear change, which was mostly done "on the button."



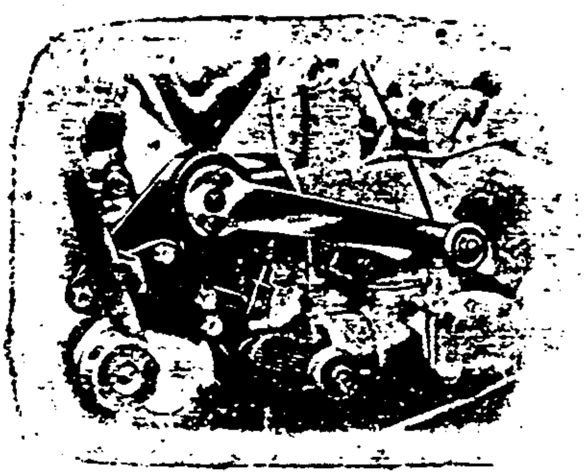
Mavro Gear-change Mod.



The original Willis positive-stop mechanism, designed by Harold Willis of Velocettes and fitted to the machine he rode in the 1928 Junior. The production version, marketed shortly afterwards, used internal springs instead of the spring-loaded cam on the splined shaft. After it had been adapted to Scotts by Noel Mavrogordato and Albert Reynolds, with complete success, the Shipley works fitted it as standard on all 3-speed boxes. Originally all the parts were purchased from Velocettes—including the mounting plate for the Scott box—but when the Velo mechanism was changed and enclosed, Scotts were permitted to manufacture the original pattern at Shipley, on the understanding that parts would be made available for old Velocettes whenever they were needed.

Sketch: *Motor Cycle*

Right: The production "conversion kit" fitted from 1934 to 1938, and sold separately for modernising hand-change gearboxes. This illustration is from the 1934 spares list.



A SCOTT-VELO GEARBOX CONVERSION

by *R. Brough*

"The Scott three-speed gearbox," the handbook tells us, "is admittedly the finest on the market," and as my old gearbox is now on the market, I shall agree entirely!

However, a four speed Scott is a more pleasant machine to ride, as I found from a brief ride on Val Ward's conversion. A similar modification is reported here.

Firstly an "old" Velo MAC gearbox was obtained. The later types have larger cases to accommodate the internal change linkage, and would perhaps have proved more difficult to fit in the limited space. The gear clusters are much the same in both types of case so nothing practical is gained by fitting the later version, though I must admit it looks neater. The box had two lugs at the base for bolting to a transverse frame member, so a dural cradle was made to incorporate a similar member. The supporting plates were originally fabricated from ¼ ins. hardboard and the dummy frame tube from ⅞ ins. wood dowel, both easily worked materials and quite suitable for mockups of the assembly. The assembly itself is secured to the frame through two ⅜ ins. holes, 9.5 ins centres as per the old undertray. After the hardboard plates were the correct shape they were reproduced in ¼ ins. dural; the frame tube was also made and this, in conjunction with a through bolt, spaced the two dural plates 3⅞ ins. apart. The nut on the end of this bolt was made with a ⅝ ins. diameter portion for the right-hand clamping lug.

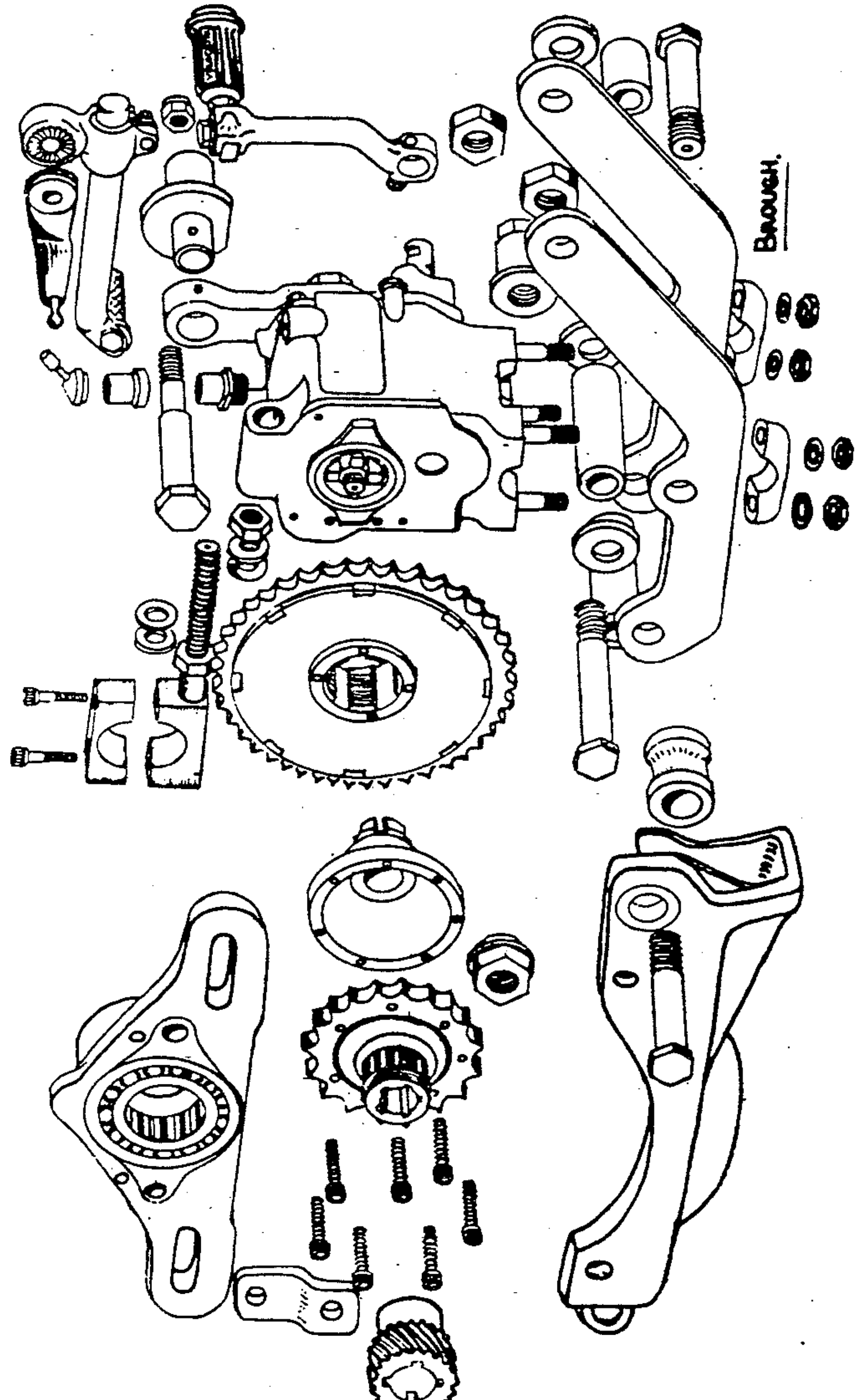
To provide support for the outrigger bearing, part of the old undertray was utilised by cutting a section ⅞ ins. wide off the engine spacing boss, straight down so as to include the driving chain channel. This section resumes its original position in the frame.

With the gearbox in position the kickstart ratchet box cleared the frame by a mere thirty-second of inch. It was, however, found necessary to mill a slot in the subframe below the oiltank to give clearance to the clutch chainwheel and primary chain. The exact position of the box in the frame must be a compromise and is dependent on whether the selector arm is at the back or the front. On this particular box it was at the front, which meant slight rebending of the oil-pipes from the pump to the crankcase.

To provide adjustment for the primary chain a "pusbolt" is clamped round the part of the subframe tube which encloses the top engine mounting bolt. The threaded portion of the adjustment bolt passes through the boss provided on the top of the box. The nuts on this bolt are provided with spherical washers as the full chain adjustment follows an arc centering about the bottom clamping lugs.

The Velo 7-plate clutch was more compact than the original Scott unit and was screwed up tight on the splined gearbox sleeve-gear, care being taken that none of the friction plates slipped out of position whilst the box was in the frame. It was found necessary at this point to fabricate two adjustment tools: a "cee" spanner for the clutch adjustment ring, and a forked spanner having two pegs to hold the sleeve nut tight whilst the outer ring was being turned.

Having got the gearbox and clutch in the frame, we could now undertake the transmission from the primary chain to the driving chain. It was decided from the outset to retain the outrigger bearing and Scott driving sprocket, the latter having provision for the speedo drive gear. An adaptor was therefore made to transmit the power from the Velo driving shaft (which takes the form of a four-fluted spline having a ½ ins. x 20 UNF thread on the end) to the face of the Scott sprocket. The internal splines were not employed. The adaptor


BROUGH.

was conical, having mating slots for the Velo shaft and a flange fitting for the Scott sprocket, to which it is held by seven 2 B.A. Allen-type cap-screws.

To secure the adaptor on the driving shaft a nut was made having a conical portion which centralised and locked the components tight. This nut was prevented from coming loose by machining the top surface flush with the face of the flange and then tinning so that when the sprocket is screwed down in position the small boss in the centre of the sprocket is tight up against the nut and pressed into the tinned surface.

Difficulty may be found in drilling the seven three-sixteenths ins. holes in the driving sprocket, especially if you have bought it from Mr. Tom Ward as I had. This had a hardness value of 67 Rockwell "C" whilst the twist drill selected for the job had a value of only 48 on the same scale ! Consequently the sprocket had to be softened by heating, in this case at a temperature of 400 degrees C. for 45 minutes in a neutral atmosphere. Seven holes were drilled because I had a 21 tooth sprocket. These holes were positioned between the teeth on a 3.375 inch P.C.D., drilled through and tapped whilst clamped concentrically with the sprocket, which was subsequently re-hardened.

With the foregoing assembled the outrigger bearing could resume almost its original position. Whilst, however, the rear slot in the bearing housing aligned correctly with the bolt hole in the under-tray section, the forward slot had to be linked up by a short length of three-sixteenth ins. by one and one-eighth ins. M.S. strip.

The speedo drive box, when bolted in position, was slightly inclined, causing the speedo cable to go over rather than under the generator.

The clutch cable on the Velo box enters via a short tube which, when in the Scott frame, is positioned directly under the oiltank. To overcome this it is possible to make a tunnel through the oiltank and possibly a subframe tube, but not wishing to infringe Val Ward's patent, I chose to fit an alloy tube which screwed into the box and allowed the cable to enter at an angle. This tube is made in three sections to facilitate fitting in the limited space. The first section is seven-eighths ins. tall, having a ½ ins. O.D. x 19 T.P.I. gas thread to suit the box ; the second part is approximately three-eighths ins. tall and counter-bored to fit over the first. The cap is turned conically so that the cable adjuster and stop, screwed in off centre, is about 30 degrees from the vertical.

The gearchange pedal was brought out approximately one inch (to clear the oil pump) by lengthing the spindle and bush on the gearbox. The gearchange pedal itself was fabricated from a piece of ⅝ ins. O.D. chromium plated B.S.S. pram handle. No expense spared on this job !

The exhaust pipe impeded the travel of the modern type Velo kickstart pedal. To correct this, the pipe was "modified" on a contraption known as an hydraulic pipe bender. I'm sure there must be a better way . . . .

To protect the underside of the gearbox and prevent road grit impinging on the clutch and primary chain, a light gauge undertray was made. This was fabricated from ⅛ ins. dural and secured by screws to "hangers" hooked over the top edge of the cradle plates.

The adjustment of the Velo clutch must be carried out with the conciseness implied by their handbook (Handbooks cost 7/6*d*., thrust races cost 21/- per set !) The primary chain is, at present, difficult to adjust due to the adjustment bolt being tucked under the oiltank. This problem will, however, be overcome. Another temporary fault is that of the centre stand cross bar, which meets the new under-tray before it contacts the stops. (Although the new gearbox is lower in the frame than the old, overall ground clearance is not reduced, being about 5 inches).

Since the installation of the box, the machine has covered 2,500 miles without any need for adjustment of the gearbox or clutch. The Velo box seems to consume less engine power than did the Scott box ; the top gear ratio remains the same at 4 :18 :1 ; third gear is 5.55 :1 ; second 7.30 :1 and first 10.65 :1, using 44 tooth clutch chainwheel, 21 tooth final drive sprocket and a 40 tooth rear sprocket.

The only Scott major component modified beyond redemption was the under-tray. Special bits and pieces, numbering perhaps 50 in all, were made from standard engineering stock, mild steel, 57/40 brass etc., but the supporting plates were of high duty duralumin.

(The "exploded" drawing of this conversion is by Mr. Brough himself. Some of the details were collated by his friend J. Gander, and some photographs were prepared by A. Redhead. Unfortunately, our publishing budget wouldn't run to the reproduction of these as well.—*Ed.*).

A BEGINNER'S GUIDE TO THE SCOTT GEARBOX

To many people gearboxes are "White Mans' Magic", something not understood except in the most vague terms, and definitely not to be meddled with. Have no fears, whether your three-speed Scott is from 1928 or 1978 the internals will be virtually identical and interchangeable, and possibly the simplest and easiest to work on of any motorcycle gearbox. Take the end cover off some boxes, and showers of springs, shims and needle rollers cascade all over the floor!

Rudge enthusiasts will wince at the memory, but the Scott gearbox couldn't be easier to work on.

The sectional drawing in "The Book of the Scott" is difficult to follow unless you are an engineer or draughtsman, so I have taken some photographs which hopefully make things easier to follow.

I must confess however that I now realise that my photographs really ought to have been turned upside down and re-labelled, as the right-hand side of the gearbox is on the left of the photos. As a born-and-bred sinistral I usually end up doing things this way! Never mind ....

.... The internals pictured are from an early close-ratio gearbox, number 886 C but the only real differences likely to be encountered are in the layshaft construction. Mine is in one piece, but built-up layshafts will also be found, in later or modified gearboxes.

The Scott gearbox is of all constant mesh type, unlike many vintage 3-speeders where 1st and 3rd are constant mesh but 2nd is "crash", and the gears themselves have to mesh and unmesh, (as vintage Sunbeam owners will be only too well aware!)

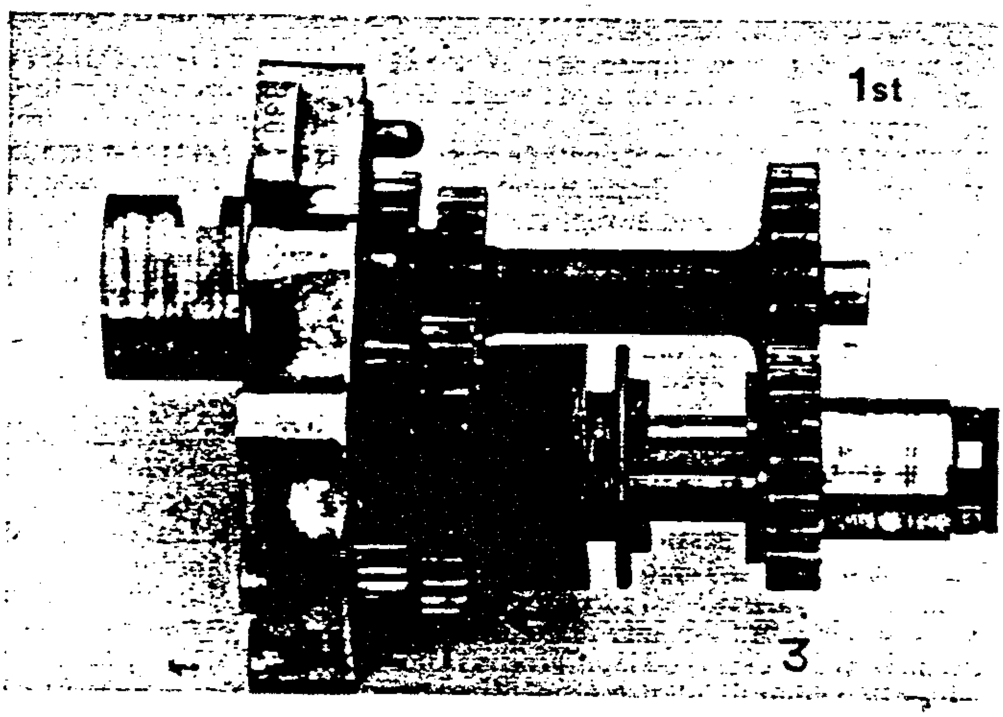
With the all constant mesh design there is little or no risk of chewed pinions unless some other major calamity has occurred. In other words all three pairs of gears are permanently meshed, with just one sliding selector dog on the mainshaft, which is moved from side to side by a robust wishbone-shaped selector fork.

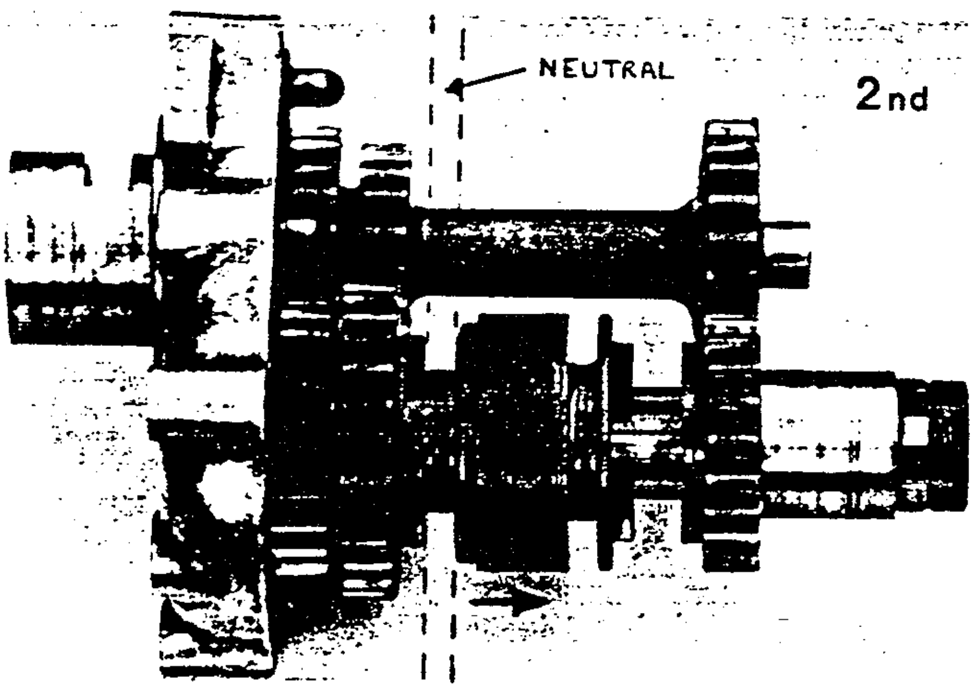
Power is supplied to the gearbox via the clutch chainwheel, which is locked by splines onto the High Gear pinion or sleeve gear. This drives the layshaft via the layshaft High Gear pinion. The layshaft provides 1st and 2nd ("Low" & "Middle") ratios only, and it's only other role is to provide a means of turning the engine over, by means of the kickstart lever, ratchet and pawl on it's right-hand end.

Putting the gear lever into 1st ("Low") gear slides the dog outwards (towards the offside of the bike) so that the castellations of the dog clutch on it's outer face engage with the corresponding dogs on the mainshaft 1st gear pinion. This action locks the 1st gear pinion to the mainshaft, and so it also rotates the matching 1st. gear pinion on the layshaft. The layshaft rotates *en masse*, and transmits drive to the clutch/sleeve gear/"High" Gear pinion assembly via the third gear pair of cogs (on the right in photos). The second ("Middle") mainshaft gear is now running freely on the mainshaft, with it's "spider" dogs running in a void in the sliding selector dog.

Putting the lever into 2nd ("Middle") gear shifts the sliding dog to the left of the mainshaft (right in photos!) passing right through the Neutral position, and engaging the "spider" dogs of the mainshaft 2nd gear, which with its layshaft mate, is the pair on the outermost right-hand side of the box (left in photo!)

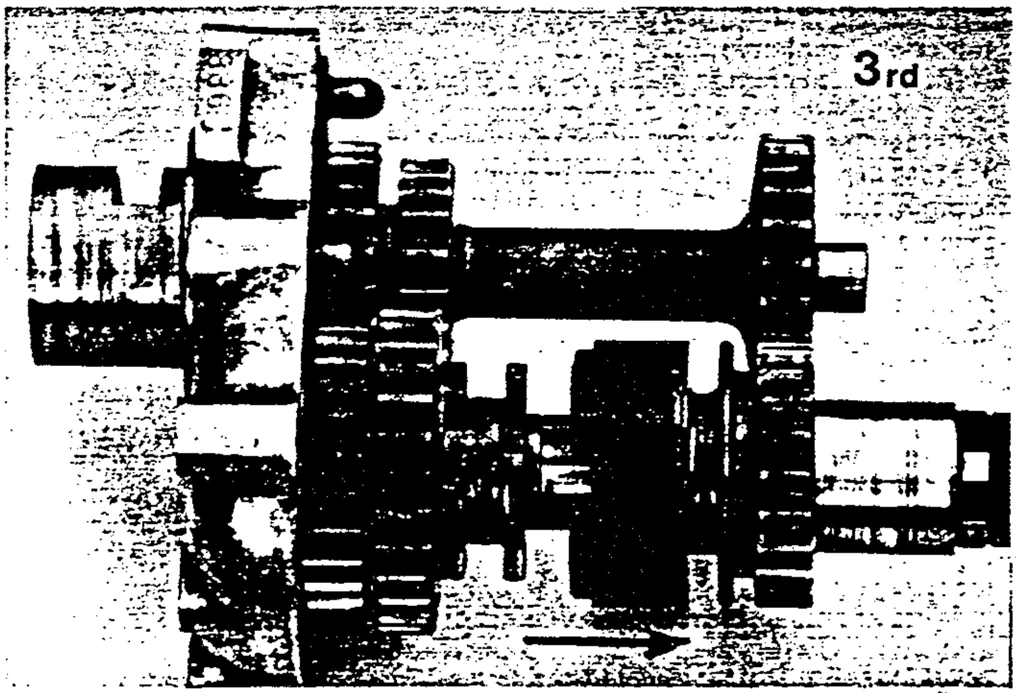
Putting the lever into 3rd ("High") top gear moves the sliding dog further to the left (right in photo!) and the dogs on it's other end lock it to the "High" Gear pinion/sleeve gear, giving a "direct" top gear. The layshaft is now "idling" and transmitting no power. As can be seen from the photos there is room on the shafts for a false neutral between 2 & 3.

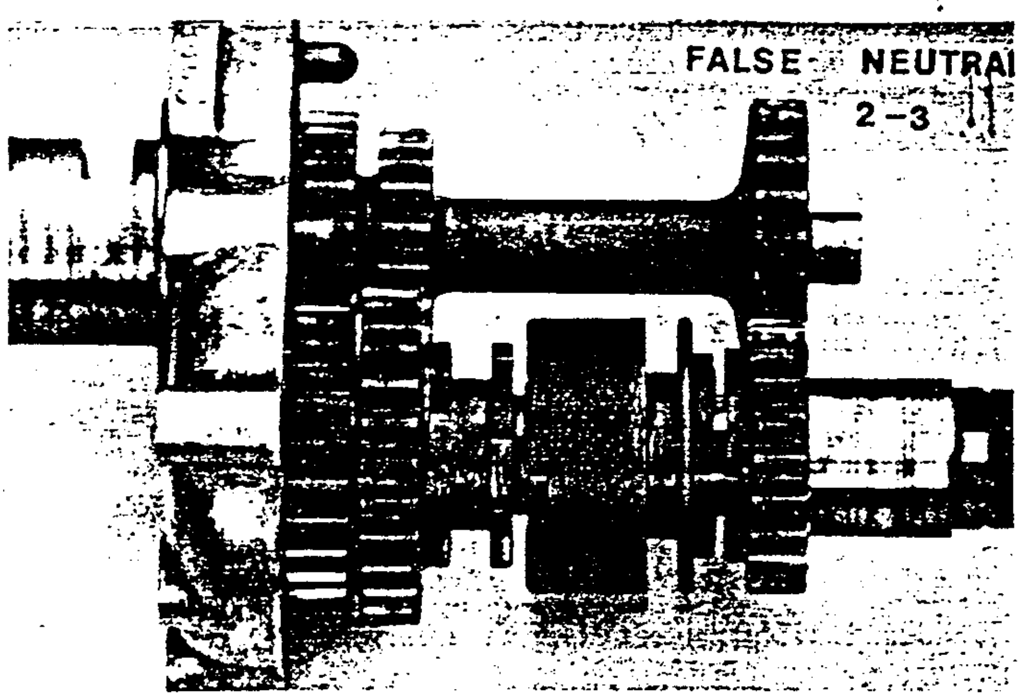




The gears, which are very generously over-engineered, and can transmit far greater power than the Scott engine provides, have teeth the sum of which (each pair) = 43 T (or should!) - The exception being the very early Shackleton design, which also has "Low" & "Middle" gear positions interchanged.

The box is so simple and strong that very little is likely to go wrong, apart from general wear and tear, and a tendency to leak oil due to the minimal oil sealing arrangements. On the subject of oil, DO NOT USE "E.P." TYPE GEAR OIL. (These extreme pressure additive oils are intended for hypoid drives, and the additives will attack and corrode any phosphor-bronze, brass, or copper components in vintage gearboxes.





A common problem is awkward gear engagement and/or jumping out of gear. Assuming that the corners of the dogs are not badly rounded, this is usually just a matter of adjusting the linkage to the selector arm (on both hand and foot change boxes) .... Put the lever into second gear position, and then screw the external adjustment on the rod or linkage until the outer (offside) face of the sliding dog and the second gear dogs are lined up in the same plane with one another (right-hand broken line on photo).

On footchange boxes the correct indexing of the gears is provided by an external indent plate, instead of the gear lever gate of hand-change machines. Problems can occur when people loose the ballbearing out of the selector bellcrank lever. They unwittingly replace it with a ¼" ballbearing instead of the correct 9⁄32" bearing, and then get mysterious selection problems!

If failure to engage gears properly still occurs on footchange models, the trouble is usually due to wear in the positive-stop mechanism, causing "lost" movement.

Most other problems seem to occur with boxes built up out of "odd" components from different ages, and this is largely due to the infamous Scott rubber Limit Gauge, in other words manufacturing tolerances. This results in too much or too little end-float on the shafts, easily remedied by shimming, or milling away protruding ends of bearing bushes. (Too much end float on the mainshaft can also cause clutch problems.)

Even with the minimal (felt) oil seals in good condition, some gearboxes throw a lot more oil out than others. In the short term a useful remedy for this is to use a thixotropic lubricant such as Shell "TIVELA Compound A" In a static situation this looks like jelly, and it will not flow out of even a large static gap. As movement occurs it liquefies and acts like a normal oil. Do not expect to buy some from your local garage. It has to be ordered from a Shell agent or lubricant factors.

Most of this excessive leakage occurs past a worn High gear sleeve and bush. Owing to the design a portion of the sleeve gear protrudes beyond its bush, to carry the clutch, so it does not wear, whereas all the area between the clutch and the teeth does wear, thus leaving a "necked" worn portion. It can be seen therefore, that simply renewing the bush is not the solution, because to allow assembly, the bush has to have an I.D. large enough to allow the unworn portion of the sleeve gear to pass through it; and so when the gear is "home" it will still be sloppy, and allow oil to leak out. The answer, without a new gear and bush, is to have the sleeve built up with hard chrome plating, (not to be confused with "decorative" chrome plate!) and then ground down to a given dimension to fit the bush, machined out clean, (or to standard size with a new bush). A similar remedy can also be applied to the layshaft if necessary.

On footchange boxes the top spindle, which carries the swinging selector wishbone needs to be the type with the large head at it's rear end, in order to provide a thrust stop. Otherwise the spring loading of the bellcrank indent ball will rapidly pull the whole assembly forwards, loosing the ball in the process! (This is a point to watch for when converting handchange boxes to footchange)

Although the vast majority of shells and end-covers are interchangeable, that is to say they will match and fit each other, at a very early (1926?) date there was made a shell and cover which had its dowel and bolt centres closer than the much more common later type. Although the shaft centres were the same it is obvious that neither the shell or end-cover are compatible with the later ones. A late Shipley or Birmingham end-cover, with integral footchange mechanism, will fit all but those earlier type gearbox shells.

One-snag of this marvellous interchangeability is that you really have no idea what ratios you are buying with a bike or spare gearbox, as it could very well have been modified or cannibalised over the years Just because there is a "C" suffix after the number does not mean it is still a close-ratio box. — It could just as easily be the dreaded "Vintage-Wide"!

Brian Marshall

(with acknowledgement and thanks to Ken Lack for his valued comments)

A BEGINNER'S GUIDE TO THE SCOTT GEARBOX (PART TWO)

Following my left-handed article in the October issue, I realised that the actual identification of gear clusters is not as easy as it could be, particularly as so many gearboxes have been repaired, cannibalised and modified over the years. I therefore had a scour through my bits and pieces and spent an afternoon counting and listing gear teeth. (Please note that I am still taking about Flyer type gearboxes and not three-speed Super boxes).

I found four different lots of ratios and these are listed below, together with the gearbox number suffix or prefix from whence they cometh. I understand that "Wide" ratios changed at box number 3193, with the earlier ones being commonly known as "Vintage-Wide".

Suffix or Prefix	LAYSHAFT No. of gear teeth			MAINSHAFT No. of gear teeth		
	1st (low)	2nd (middle)	3rd (high)	1st (low)	2nd (middle)	3rd (high)
"W" VINTAGE WIDE (pre-3193)	14	19	25	29	24	18
"CM" CLOSE TO MEDIUM	17	22	25	26	21	18
"C" CLOSE	17	20	23	26	23	20
"W" WIDE (post-3193)	14	21	25	29	22	18

As can be gathered by scrutiny of my chart, it is possible to do a limited amount of juggling with the ratios, (but only of course if you have the built-up type of layshaft as opposed to the one piece type), and many race and sprint competitors have done this in the past. The golden rule is make absolutely sure that the total number of teeth on each pair of gears adds up to 43. This may seem obvious but it is possible to assemble a gearbox with, for instance, the second gear pair only adding up to 42, and it will work for a while! — making horrible noises in the meantime, and resulting in rapid wear of the teeth which of course aren't properly meshed. You may laugh, but I have seen it! Incidentally, the same machine had the pistons in back-to-front and it RAN (but only just). It also had wooden handlebars, but that's quite another story, and I must not digress.

Wherever Scott owners gather one hears mention of mysterious gear ratios such as "Sidecar-Wide" and "Ultra-Close" or "TT". I am now reasonably convinced that this is all due to faulty nomenclature, just different names for the same thing, and I think it is fairly safe to assume that:- "Sidecar-Wide" is the same as "Vintage-Wide", and that the "Close-Medium" box is often just called "Close", with the real "Close" ratios being called "Ultra-Close" or "TT ratios" — as well as "Close!" With three different names for the same thing no wonder people get confused! The only safe identification is to count the teeth on the cogs; although after spending an afternoon doing just that I found that an educated guess becomes quite easy just by looking through the inspection hole, or sticking your fingers in — in particular, the larger First gear cog of the "Wide" and "Vintage-Wide" ratios is quite obvious with a little practice.

I thought I had sorted it all out in the limited grey matter then I found an end cover with an "M" prefix before the number. My heart sank, and it was several minutes before I realised that the "M" was an upside-down "W" and it was down to a lapse of concentration at Shipley and not some mysterious gear ratios!

That huge gap between 2nd and Top in the "Vintage-Wide" box causes real problems. You rev up to full yowl in 2nd, drop into top gear and suddenly wonder where the acceleration and noise have gone to! It is just acceptable with the better low speed pulling of a short-stroke engine, especially a 596, but a long-stroke engine, with less tractability can find it very difficult to dig itself out of that gap sufficiently to build up some revs and power, especially if it is only a 498 and you are well loaded with a passenger or running uphill. That is when you pray for a four-speed box!

Some long-stroke engines will slog however. The 498 "R" type engine in my '29 Rep pulls like an old gas engine and ticks over contentedly like a side valve, even when the ignition is advanced far enough to cause kick-backs when starting. I have never been able to understand that one! — which brings me to another query. Why does the advance and retard control have little or no discernible effect on the running of some Scotts, and dramatic effects on others? Is it the engine or the magneto? **R.S.V.P.**

B.M.

P.S. Three-Speed Super owners should not despair, as an article on their version of the Scott gearbox is being prepared, (not by me I hasten to add), so watch this space!

TECHNICAL TOPICS

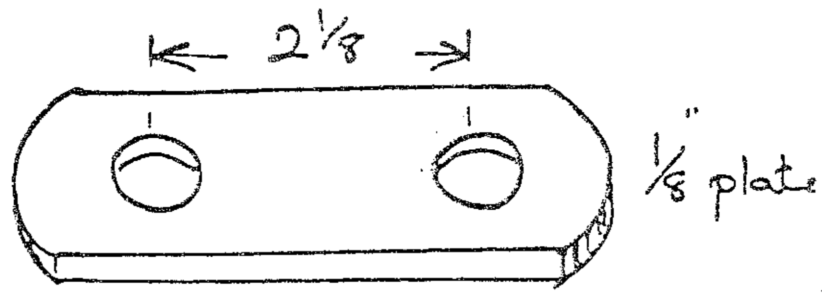
V19/6 Oct. 1995

Potty

Gearbox (Potty mod. no. 12)

Scott gearbox shells are pretty strong and do not usually suffer many problems. The odd boss may get knocked off by a bad kick-start stop (use full-width post-war type with rubber buffer). But abuse such as sprinting, dropping the clutch too quickly, or heavy sidecar use can show up some weaknesses. These mainly manifest themselves in an undertray or outrigger crack or in the box itself between the two mounting studs (or bolts) in the base of the shell.

Better support for the gearbox and undertray can be achieved by making Potty Mod. 12, a simple heavy-gauge plate in place of the two thick washers. This relieves a lot of the stress to studs and bolts and keeps them the correct distance apart. I do not claim to be the first person to have thought of this, but it is so simple and effective.



Base washer for gearbox

BELOW THE WOBBLY WALKING STICK

A glimpse inside a 1924 three-speed Super gearbox and clutch

Chris Boorman

John Lindsay, attending to some work on his three-speed Super, thought that I should inspect the transmission and perhaps submit an article for *Yowl*. To a man with a shed of old bikes and a clapped-out family car, this was manna from Heaven. Just what I needed, more work.

The gearbox is of normal bottom two stud fixing, but the fitting strip is 1½" wide. The mag sits piggy-back on top of the shell and is driven from the clutch drum. This method was resurrected for the single downtube Flyers. On dismantling, four points stuck out:

1. The first class condition of the cogs, bearings, bushes, engagement dogs, *et al.* The only signs of tiredness were on the mainshaft, signs of a long-ago seizure under first gear, a wear ring caused by the top gear sealing ring felt, and the usual spline wear under the outrigger sprocket.
2. The 1-2-3 spacing of the gears instead of the Flyer's 2-1-3 set-up.
3. The clutch hub is carried on a large bush in the gear casing and top gear is splined and carried inside the hub:
4. The clutch is push-rod operated through a hollow mainshaft like a Burman or Sturmey.

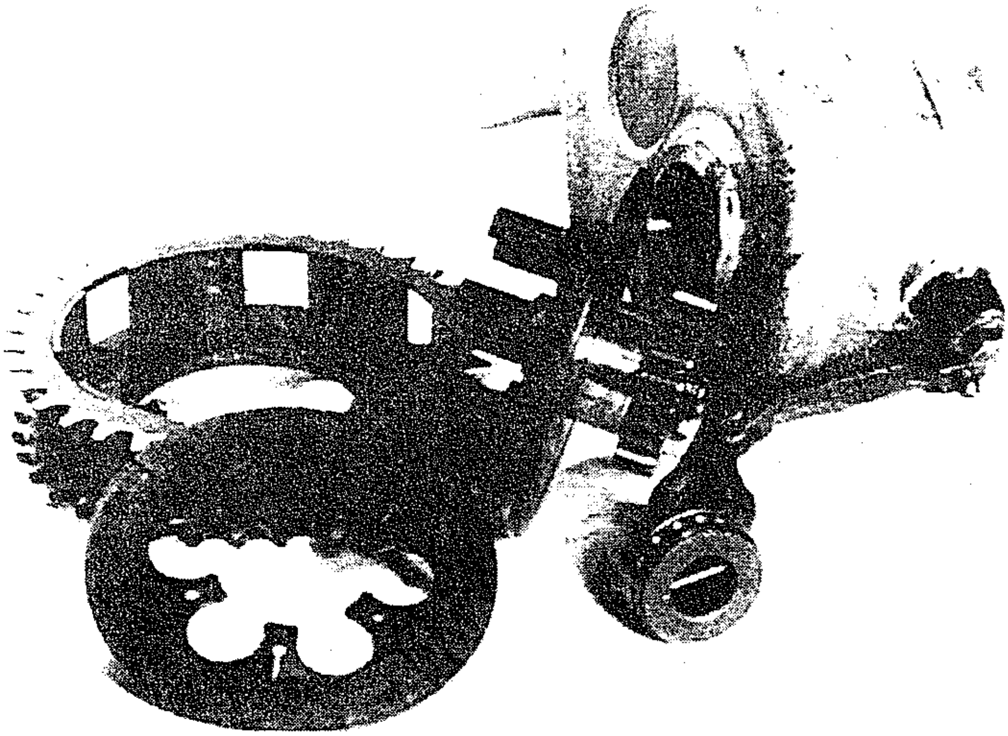
The gears are of a finer pitch than on later Flyers. The tooth count is thus: first gear 18-38, second gear 26-30, top gear 24-32, lay gear being 18-26-32. The lay gear is undercut beneath top so the bearing is right under the load. Top gear is splined into the clutch hub which runs in a large diameter bronze bush in the gear case. So no clutch load hanging on the end of top gear. Top gear bolts up to the clutch hub with a very natty double nut, the outer part being a gland which compresses a felt ring down on the mainshaft. Very steam pumpish including packing wear groove on shaft.

The clutch withdrawal mechanism is very Norton quickthread-looking and may not be original. Evidence of a good soldering job within the large dome nut which retains the first gear bearing and also carries the quickthread.

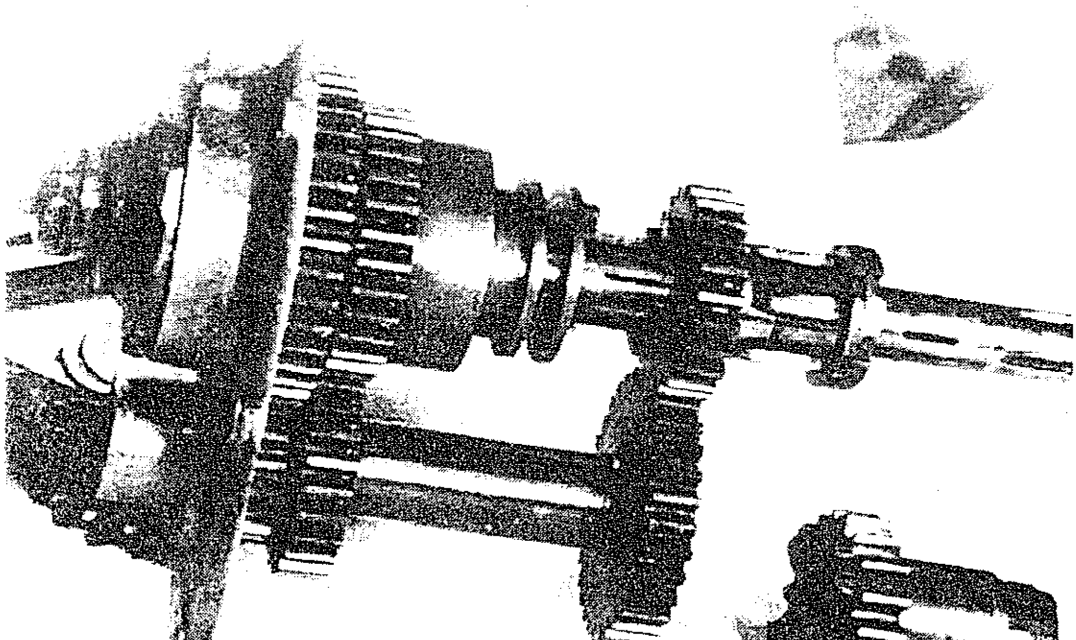
The quickthread transmits the normal silver steel rod three-quarters of the way along the mainshaft. Here the mainshaft is pierced with a slot right through, ¾" long by ⅛" wide. A flat key $^{5}/_{16}$" and ⅛" thick protrudes though the shaft and carries the top hat-shaped clutch release thrust bearing. The bronze ball cage and hardened thrust face retain the key. This assembly bears against the lined outer clutch plate that carries the springs in the normal way. The drawback to this system seems to be that when everything is worn you will run out of mainshaft slot before engaging the clutch.

John has never had a kick-starter for his bike and it is something of a mystery how it works. The end of the lay gear has the normal square protruding through the case, though it has no tapped hole in it, only its machining centre. So how was the ratchet secured?

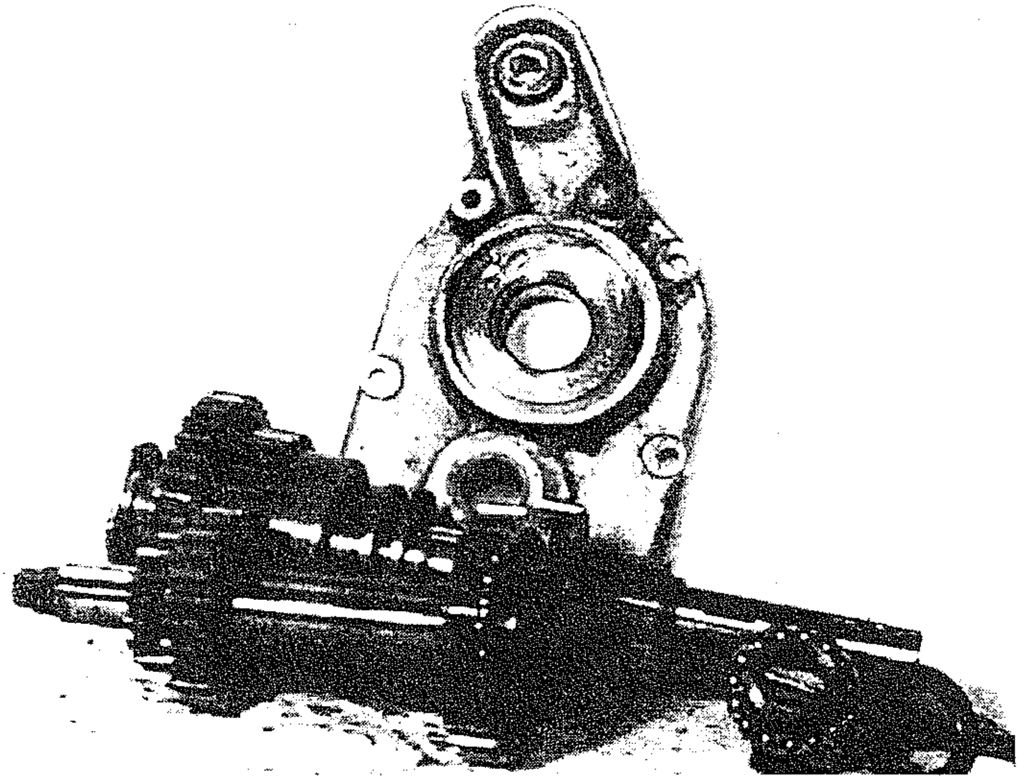
Peter Maddox is on the case and is seeking a machine in Ireland to take some photos of it. Can any member help John out as this is totally different from later kick-starts?



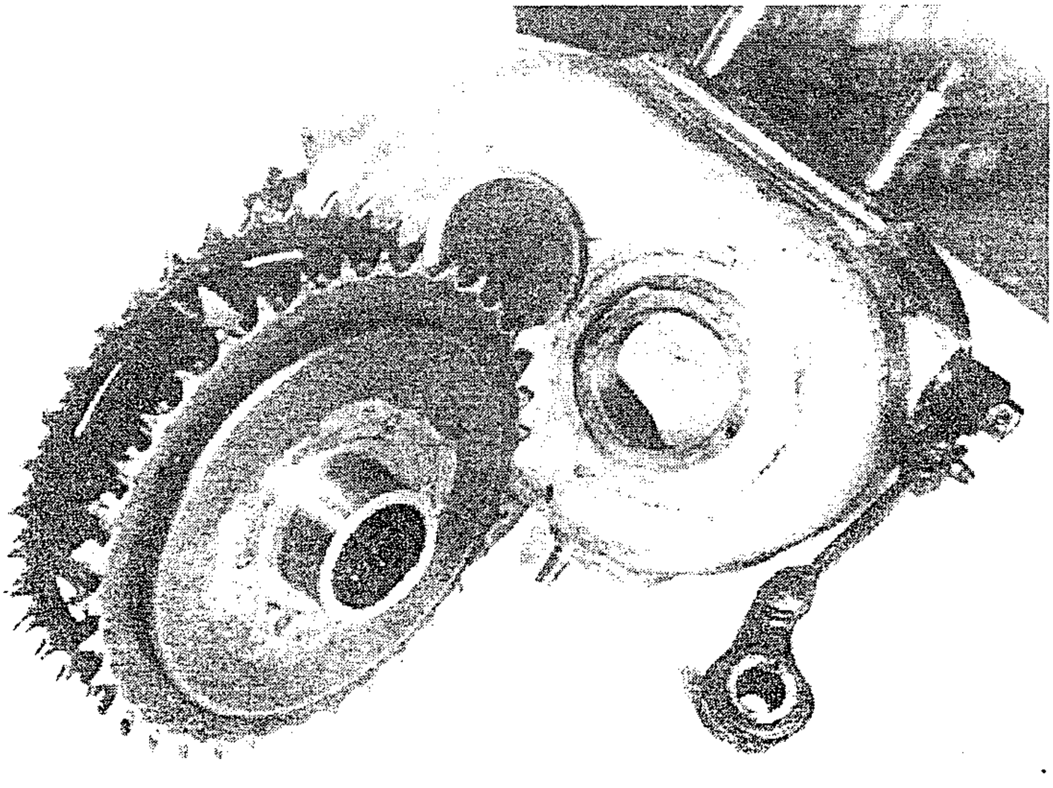
This shows large diameter bush in gear case, clutch hub with top gear fitted inside and normal $^{3}/_{16}$" roller bearings, clutch thrust bearing with flat key, and clutch wheel.



Showing 1-2-3 gear make-up alongside standard Flyer top gear, quickthread clutch withdrawal in end cover and slot in mainshaft, double gland nut on top gear.



Showing slot in mainshaft and clutch thrust bearing, 1-2-3 lay gear and bearing under top gear.



Clutch carried in large bush in gear case. (Photos and captions by Chris Boorman.)

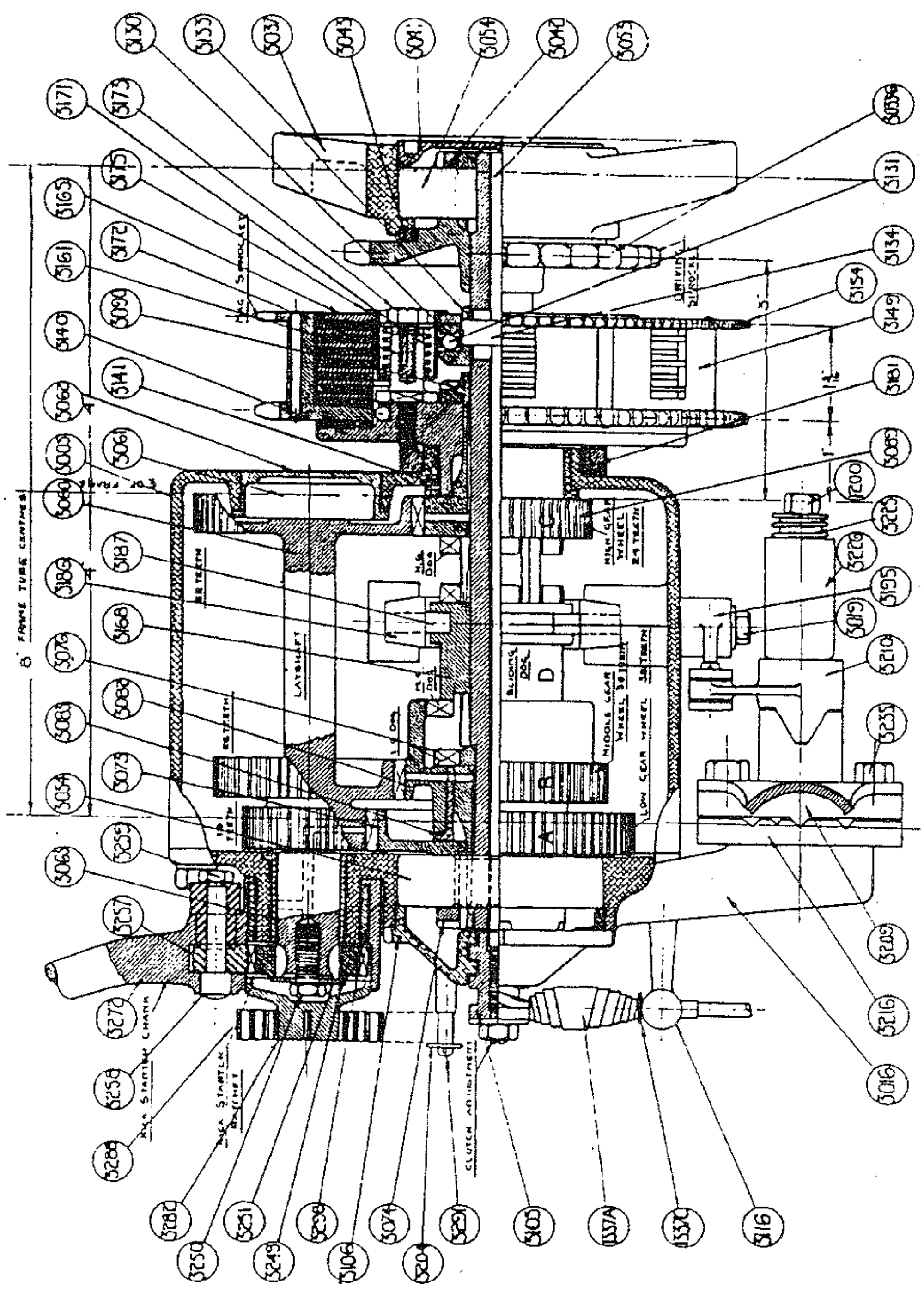
V20/6 Oct 1997

Why did this odd box only run from 1924 to 1926? People have stated that it was unreliable and fragile. I would have said it was ideal for the lightweight Super and is no more fragile than any other 1924 gearbox. I like the rotary face-cam spring-loaded gear index, though it is not as simple as the ball in the hole index. Probably the later box was cheaper to make and easier to machine.

There you have it — a glimpse into a rare transmission.

V20/7 Dec 1997

THREE-SPEED GEAR 1923-5 TYPE



See letter: Nick Sloan

Wobbly Walking Stick

Dear Tom Wess,

The article by Chris Boorman was really my cup of tea, and it occurred to me that the drawing in my 1925 issue of *The Book of the Scott* (Second Edition — one shilling), may help resolve some of his questions. Later editions had drawings of the final gearbox (admittedly the finest on the market) and that fitted to the Wobbly Walking Stick Supers, but lost the first Shackleton designed 1923-5 unit.

As you can see the squared end of the layshaft is tapped, and the kick-start ratchet is in the usual position, if a little narrower than the later gearboxes, and I imagine that it is the return spring on the extreme outside.

The clutch withdrawal is very similar to the Norton/Sturmey Archer arrangement and is as Chris describes. Hopefully the kickstart details may help John Lindsay in putting his machine back to original.

Nick Sloan,
Milton Keynes, Buckinghamshire.