Best Results from Overdrive

Second in a three-part series

by George Schmidt

When Hudson first adopted optional Borg-Warner overdrive (in 1940), it was no longer a novelty, having already outgrown a few early minor teething (!) problems during several years' use on a number of other car makes. Hence, while Hudson overdrives were of three different types — one with semi-electric and two with full electric controls — they were not noted for mechanical problems, and most overdrive servicing still consists of checking the electrical components (all external) for occasional poor contact or shorts. The system adds much to driving convenience and flexibility, and though marketed in later years almost entirely as a fuel (and engine) saving device, it had real value as a performance accessory as well — particularly when combined with the engine torque, characteristic gearing, and top roadability for which Hudson was known.

Borg-Warner overdrive, though nearly ubiquitous in the U.S. for years, was of course not the only available means of providing more than three useful forward speeds. A number of quality cars before 1920, including the big Hudson "6-54" for 1914-15 (its last two years of production) featured 4-on-the-floor transmissions. Some makes had the usual direct drive on top gear, but Hudson and several others at that time had a direct-drive 3rd gear with a manual overdrive on 4th. Either type of 4-speed could be made to serve about the same purpose if fitted with an appropriate rear axle ratio. The type without overdrive required a "higher-speed" (numerically lower) rear ratio to compensate.

But Hudson's new Super Six the next year was noted for its ability to rev both high and long without harm or undue noise, and so the 4-speed was dropped. The fad by then (understandable in those pre-synchromest days) was for engines detuned to give an unusually wide torque curve — at whatever cost in peak horsepower — so as to reduce the need for shifting as much as possible. It was the era of slogans such as "3 to 70 MPH in High Gear." The Super Six was exceptional in offering snappy performance despite all this . . . and without falling apart in the process.

With the coming of synchromesh c. 1930, however, another generation of U.S. 4-speeds was seen, Graham's "Twin Top" being perhaps the best-remembered one. Unfortunately their vogue was brief. Some had reliability problems, and then too, nearly all were supplied with ill-chosen rear axle ratios which offered practically no gain in top-end cruising ability, but only an extra "stump-pulling" or "grandma" low gear which was seldom of use on a passenger car. Moreover, the Depression market for sports or enthusiast vehicles was pitifully small, and these transmissions were rather lost upon the upper/middle "family-car" trade. They were, however, the immediate predecessors of B-W's overdrive design.

Hudson Hornets in the 1950's managed to win most of their spectacular victories using only the stock 3 speeds. The rather wide gaps between transmission ratios proved not to be a serious handcap except on the occasion of one or two forays into the field of road or sports-car type racing. There were also some racing Hornets with 4-speeds, but these were basically Hydra-Matics (see below).

The 1960's, of course, brought a resurgence of interest in straight 4-on-the-floor transmissions, due to the sports-car influence, along with a muscle-car need for higher torque capacity and quicker upshifts than the B-W overdrive could provide. Warner's "T-10" box was the leading U.S. design, used on several makes including American Motors and Studebaker, and later copied and strengthened by other builders as well.

There have also been 4-speed boxes automatic on 2 speeds (Reo Self-Shifter; Chrysler Vacamatic), and indeed the standard 3-plus-overdrive still belongs basically to this class. With Drive-Master added, of course, it becomes automatic on 3 of the 4 speeds. As for 4-speed all-automatics, GM's Hydra-Matic (original non-"Turbo" variety) was the most successful . . . often with non-GM engines such as Hudson, Lincoln, and (under license) Rolls-Royce. It was a good wide-ratio automatic noted especially for its solid bite in first gear (3.63 low). In stock form its 4 ratios were not all ideally subject to control by the driver, but they were well-spaced to perform effectively with relatively little "slushbox" assistance, as compared to later-type automatics.

A parallel line of development that goes back at least to the pre-W.W.I Cadillac is the 2-speed rear axle. This, like overdrive, provides an optional extra ratio — or several of them, if it is used in combination with each of the transmission's regular speeds — and is usually electric- or vacuum-controlled. As built by Columbia Axle Co., it was offered through the 1930's on several U.S. cars (Auburn; Ford products) as an alternative to B-W overdrive. Today the 2-speed axle remains of interest, not just because of use on trucks, but because it may still reappear on cars of the future . . . economics and bureaucrats permitting. Its latter-day advantage over the other gear layouts is that it will readily fit automatic as well as stickshift models. Now that most U.S. cars again come with only 3 speeds (howbeit in automatic form this time), the added flexibility of having a "performance" and an "economy" axle both in one would be especially useful, and several modern prototypes have already been successfully tested.

In Europe, plain 4-on-the-floor never lost its popularity, but there have been overdrives as well — notably the Laycock-deNormanville British-made unit for cars such as Jaguar, Volvo, and Triumph. It mounts usually at the rear of a manual gearbox, much as with B-W, although there has also been a version designed especially for cars with 2-piece driveshafts similar to Hudson's — one which mounts neatly in isolation on the center island between front and rear shaft sections. The distinctive feature of this British overdrive (other than its price tag) is that it can be upshifted under load, similar to most automatic boxes, when desired. It uses friction clutches, and sometimes hydraulic as well as the usual electrical controls, for this purpose; and since it is often used with a 4-speed stickshift, it can provide 5 or more useful ratios.

France has produced the expensive Pont-a-Mousson 5-speed gearbox, offered here in the 1950's on the aristocratic hybrid (Chrysler-engined) Facel Vega. And in Germany, the classic late-1930's Maybach "Zeppelin" (named for its V-12 airship engine) had a system that even Drive-Master and Electric Hand owners could envy: a compound transmission which gave 7 or 8 forward speeds in much the same manner as on some large trucks . . . except that all of them, along with clutch and throttle, were effortlessly vacuum-controlled, and moreover could be preselected just as on Hudson or Terraplane or Cord.

Normally, overdrive Has been designed as a means of adding on one or more extra ratios to those already provided by the standard gearbox. However, there have been a few exceptions. Volkswagen, for example, has featured an "overdrive 4-speed" of sorts, with top gear being a very mild OD ratio (0.9 to 1), this merely taking the place of ordinary high gear, since there is no straight 1:1 direct drive. Even Hudson at one time, c. 1930, seems to have offered an optional "speedster" transmission (at about $10 extra) which was basically a standard 3-speed with second gear removed and an overdrive ratio fitted in its place. The resulting transmission must have been decidedly "wide-ratio" between low and high, but perhaps this was a simpler solution, productionwise, than having to offer an optional extra-high-speed (numerically low) rear axle ratio for the speedster models. Unfortunately the term "overdrive," like many others, has suffered occasional violence at the hands of advertising copywriters. During the 1930's, especially, it was loosely applid to nearly any transmission layout which offered 4 or more forward ratios, even when the top gear remained a simple 1:1. Properly, of course, the term applies only to a device, geared or otherwise, which causes the output shaft to rotate faster (though with less torque) than the input.

The man credited with invention and design of Borg-Warner overdrive, as readers of *Special-Interest Autos* magazine (Mar.-Apr. '74 issue) know, is independent auto engineer William B. Barnes of

". . . 3 to 70 mph in high gear!"

Muncie, Indiana. He is the holder of the original patents, and of about ten more on later improvements. B-W produced his invention — about 10,000,000 units in all, making it by far the most widely used of any automotive overdrive device — from 1934 through 1971. Then, as he has explained, "Ford and Chevrolet decided there wasn't enough call for them after 1971. AMC went along, and I understand Warner Gear has scrapped the tools. Very possibly they wish they had them back right now."

A "Freewheeling" device — an overrunning or "one-way" clutch placed in driveline — is an essential part of all B-W overdrives. Whenever overdrive is not engaged and not locked out, this device operates so that driveshaft and rear wheels are free to turn faster — but not slower — than transmission mainshaft. It thus facilitates smooth upshifts, particularly into overdrive gear, without requiring use of clutch pedal.

Freewheeling devices were in fact offered as a separate option on a number of pre-overdrive transmissions. The purpose was to allow most upshifting to be done without use of clutch pedal, though sometimes the device was also combined with vacuum clutch operation. A minor saving in gasoline and engine wear was another advantage — at the cost, however, of some added wear on the brakes, since engine braking was eliminated, much as with a modern automatic. As with overdrive, of course, the device could be locked out when not wanted. Hudson offered the freewheeling option in late '31, '32, and '33; and several Brand X's offered it for a longer time. This form of freewheeling provided no additional gear ratio, but did help to make routine gear shifting easier.

With any overdrive or 4-speed, much of the practical advantage over plain 3-speed operation depends upon a suitably closen final drive ratio. Hudson stepdowns normally came with 4.11 to 1 rear axles, but with 4.55 to 1 when overdrive-equipped (unless customer ordered vice-versa). Since OD ratio is 0.7 to 1, calculations will show that changing the rear axle in this way actually neutralizes or cancels out just about one-third of the effect of the overdrive gears, trading it for a corresponding but of extra accelerative punch in the transmission's three standard lower speeds instead. Most Brand X's also offered a comparable change in rear-axle ratio for their overdrive models unless otherwise ordered. The idea was to give drivers at least a small portion of extra advantage at the bottom end as well as at the top; and in particular to offer smoother convenient starts in second gear for most general driving (especially noticeable with Drive-Master, of course). Low gear was thus relegated mostly to "emergency" use (meaning occasions when a Hydra-Matic Olds 88 with delusions of superiority was staged in the adjoining lane, perhaps). As for the slight corresponding loss of effortless cruising performance in overdrive at the top end, it was probably considered, even twenty years ago, that in a country as benighted with unrealistic speed limits as the U.S., such a loss would not be of primary importance most of the time.

However, the 4.11 axle did remain available as an option with overdrive; and while only a small minority of stepdowns were so equipped originally, most Hudsonuts have by now discovered that the 4.55 axle is a bit *de trop* with regard to engine wear, noise level, gas consumption, etc., and that even the 4.11 has quite sufficient lower-end sock for nearly all occasions — especially when combined with the extra-wide-ratio 3-speeds that were fitted to most stepdowns (both with and without OD). Hence the general rule when adding overdrive has been to retain the original 4.11 axle, and even some cars born with OD have been fitted with a 4.11 replacement. In effect, of course, this means that the 3 standard speeds remain exactly as they were without OD, and the 4th or overdrive ratio is simply added above them. The result is an outstandingly good car, with somewhat improved gas mileage as well. Top speed in good tune is generally just about 100 mph in OD, and although a mile or two of open road may be required to gain those last few points above 90 or so, the engine even at that speed does not roar itself uselessly to death, but is held quite close to its most effective rpm range by the "tall" gearing (unless OD is inadvertently kicked down!). On the other hand, the car's best normal cruising speed with these gears — the pace it just seems to choose when "given its head" (in saner times than these, of course) is generally in the 75-85 mph range — noticeably higher than would be comfortable with 4.55 axle or without OD. Nevertheless it still performs good-naturedly at all legal as well, with OD gear being useful as low as 25 or 30 mph when no acceleration is required. In fact, all of the gears, including low, are useful in ordinary driving — which is seldom true with the 4.55 axle.

Actually, even the 3.90 to 1 rear end, intended for Hudson models with Hydra-matic, should be quite usable with the extra-wide-ratio 3-speed manual (except perhaps for 2nd-gear starts), although the overdrive, if any, will then be very "high" indeed, so that most engines may not have adequate torque to pull it effectively . . . but the top speed of a Hornet so equipped should be more than satisfactory.

These gear relationships may be clearer if we remember that when overdrive engages, the effect is precisely as if a car's 4.11 to 1 rear drive ratio were suddenly changed to 2.88 to 1. This latter figure represents a true "economy" or "highballing" ratio — which explains both the fuel economy and the high top speed (and also the poor acceleration when OD is used at low car speeds). Even the 4.55 to 1 axle ratio is thus reduced, in effect, to 3.20 to 1 (a good moderate-economy ratio) while OD is in use; and of course a slight additional effect can be gained by using somewhat larger rear tires. But with a 3.90 to 1 rear end, the resultant ratio becomes 2.73 to 1, which is a bit "tall" for most engines to pull, especially without any fluid or torque-converter slip in the driveline such as most automatics would provide.

Speedometer gearing, after any of the above items have been changed, will usually require some correction as well. The most frequent instance is addition of overdrive to a stepdown with 4.11 rear axle. This ordinarily calls for retaining the

> **retain the 4.11 gear when adding overdrive . . .**

speedometer pinion (usually 15-tooth) which was originally used with that car and axle, rather than the one (18-tooth) commonly found with a Hudson OD unit. Otherwise car speed and mileage count will read considerably lower than their true value. Sometimes the same can be done with governor pinion (if car's original 3-speed had one, perhaps for VD Clutch or HDM control), but here the use of an 18-tooth pinion (the one commonly found with OD) seldom does any harm, often raising the effective cut-in speed just about enough to compensate for usual wear and again in governor. And apart from wear, this 18-tooth pinion will tend to engage OD at the accustomed engine rpm, regardless of axle or car spped (see next sections).

However, the 15-tooth pinion will be approximately right for speedometer, although it may possible by found to overcompensate a bit, giving slightly higher than true readings unless car has specially oversize rear tires. Factory parts book recommended 16-tooth pinion (speedometer and governor) for use with the special option combination of overdrive plus 4.11 axle, but these pinions are scarce (at least on Hudson) and may have to be found, if at all, on a Brand X or at a shop handling Stewart-Warner parts. The 16-tooth speedometer pinion will give readings almost 7% lower than the 15-tooth (1 mph out of each 15 shown) . . . or readings 11% higher than the 18-tooth.

Added to gearing error in causing high speedometer readings is the fact that carmakers have long tended to make their speedometers read a bit optimistic in the first place (not that Hudson was among the worst offenders). Undersized tires are another cause of high readings. This refers, of course, to the tire's effective rolling radius rather than to its width or overall size, so that modern "oval" types, if used on an old car, can be at fault even when quite adequate as to load capacity and traction. Old speedometer heads may sometimes lose enough of their magnetism to read low and thus help cancel such errors, but not with any certainty. And these days, particularly, it should be entirely sufficient to obey the law without throwing away a few more mph even below that level, due to a "high" speedometer.

A further complication is that the driveshaft gears on these cars (used to drive both pinions) were not all the same. Most had 11 teeth, and come with different centers to fit either the plain or the OD output shaft. But some had only 10 teeth, and were used (along with 15-tooth pinions) on the plain 3-speed models with 4.11 axle and smaller "standard equipment" (7.10) tires. A 10-tooth gear of this type sometimes appears to be only "5-tooth," since the teeth run spirally, almost worm-fashion, and thus join end-to-end in pairs; but the ratio effect is that of 10 separate teeth. A variety of driveshaft gears was available from S-W; however, all Hudson overdrive units for some years came with 11-tooth gears only, so that there is the possibility of speedometer suddenly reading 10% higher when OD is added to car, unless pinion is changed to counter-correct. This probably will require a 16-tooth pinion; perhaps even 17-tooth in some cases, either being easily installed and tried out.

On the other hand, changing the driveshaft gear itself, even when a correct replacement is available, is an awkward task, requiring first the removal of U-joint flange from end of shaft with a suitable wrench and puller, and then the careful unbolting and removal of tailshaft housing. On overdrive models, also, it is very necessary to prevent tailshaft from sliding rearward along with housing, or the result will be a shower of freewheel rollers which then must be gingerly put back in place and kept there (perhaps with thick sticky grease) until unit is reassembled. Most Hudsonuts will settle for the best correction that can be obtained by changing pinions only (unless OD must be disassembled anyway).

All of these gearing changes are intended merely to compensate for differences in rear axle ratio, tire size, etc. They should not be used (except as a stopgap) for attempting to correct a faulty speedometer head — first, because odometer count will then be wrong; and second, because head errors are seldom of the linear sort (i.e., with uniform per cent of error at all speeds) that could be corrected by gearing.

For other axle/transmission combinations, the same basic rules apply: More teeth on a pinion will cause speedometer to read lower (or governor to operate at a higher car speed). More teeth on driveshaft gear — which meshes with both pinions — will make speedometer read higher (and governor cut-in speed lower). A numerically higher axle ratio (such as 4.55) will make speedometer read higher (and governor cut in lower) unless corrected. Bigger tires will cause speedometer to read a bit lower (and governor to cut in a bit higher) — so that in mild cases this is often the only corrective needed, with added benefits in appearance, traction & handling, longer wear, etc. at the same time (provided they are used on all four wheels). Corrective effect can be lost when tires are soft, however.

stock overdrive cut-in speed is 19-22 mph

Thick treads, on the other hand (mud and snow type) may add the equivalent of one tire size (as, 7.10 to 7.60-15).

Most late-model S-W speedometers, and many old ones, are calibrated for a cable speed of 1000 turns per mile; but others, including the '48- '49- '50 Hudson stepdowns, for example, were built for 2000 turns per mile (or roughly once per only 2′ 8″ of car travel). This fast cable speed is OK for low-range accuracy, but it makes correct lubrication especially important. Ordinary oil or grease can cause serious cold weather problems, and so can no lubricant at all. For cables, "Lubriplate" (or one of the other greases intended for internal brake parts) is somewhat better; and there are also some graphite products (e.g., Panef) which can be used. Best of all is probably Stewart-Warner's own brand of special cable grease which is temperature-resistant and tinted an appetizing strawberry pink. In addition, S-W has a special lubricant recommended for speedometer heads, and there is an oil hole and wick provided on most models.

These lubricants will clear up most cases of noise, pointer wobble, etc.; but for smoothest operation it is also well to route the cable under dash so that it can run in a perfectly straight line from rear of head for at least several inches (tie or wire it if necessary).

Hudson speedometers for 1951 were changed to the standard 1000-revs.-per-mile type, and this necessitated the placing of a small right-angle geared "adapter," of 2:1 ratio, betweem transmission and lower end of speedometer cable.

How to know when your speedometer is accurate? This is sometimes the most difficult part. The head itself can be checked professionally on a machine; and if there is a highway available which is marked off in a succession of measured miles (some are marked this way for speed-trap purposes!), the car's odometer count, at least, can be verified with fair accuracy. Some experienced rallyists and test drivers, given a good stopwatch, can even check car speed quite closely by this method. Or if a friend's car is known to be of better-than-average accuracy, a check can be made by following him for a few miles at a set of prearranged speeds. Otherwise, since most of us do not have access to 5th-wheel equipment as used by auto-magazine reporters for tests, probably the only alternative is the one offered by cooperating police in some communities, who on certain occasions (sometimes at regular intervals) put official radar equipment to constructive use by allowing motorists to check their speedometers against radar on a selected length of road. This is a real public service, but is not available in all areas.

Stock cut-in speed for overdrive on most Hudsons is about 19-22 mph, although this may be found a bit low for use with some rear axles, since the overdrive should be able to disengage itself, as car slows down, without perceptible engine bucking and without requiring use of clutch pedal (whether car has Vacumotive Cluch or not). Sometimes, too, the problem becomes worse because most governors tend to operate at a slightly lower speed when old. Cut-in speed can usually be raised, however, simply by installing a governor drive pinion with more teeth (see preceding) — unless, of course, car already has 18-tooth pinion. Note that governor is designed to cut the vacuum clutch "in" when it cuts overdrive "out," and vice versa (except in the lower gears); and on models with Drive-Master, the automatic gear shifting speed is normally about ⅔ of the overdrive speed, using any pinion.

If necessary, cut-in speed can also be raised by altering governor rotor slightly. Drive out crosspin and remove rivet from shaft, draw out the rotor, and carefully take it apart (do not bend metal tabs any more than required). A coil spring will be found inside, sometimes colorcoded (e.g., green for early stepdowns without HDM). Drive-Master models have a weaker, uncolored spring of the same size, but with a second smaller spring placed inside this. The large spring alone controls gearshifts, and both springs together control OD engagement.

With either type governor, the simplest correction is to add a few narrow washers or spacers at upper end of the large spring. On HDM models, this will raise both cut-in speeds slightly.

An alternative is to find a slightly stiffer spring to replace the original. On single (non-HDM) models it may even be possible to find a Brand X governor factory-equipped with a stiffer spring.

Another method is to remove the standard spring from an ordinary single-acting governor and install this in the double (Drive-Master) governor, without disturbing the small inner spring. This will raise both cut-in speeds considerably, but the lower (gear-shift) one in particular. If effect is excessive, try changing back to a drive pinion with fewer teeth.

Curt Fouse (May '75 *WTN*) suggests drilling out the eight small governor weights to lighten them. This will work if all are kept uniform, and with Drive-Master it may be the best way of raising both cut-in speeds without bringing them closer together. If spare weights are needed, note that they are identical in the single and double governors.

To raise OD (& vacuum-clutch) speed alone, however, without affecting gearshift speed, it is necessary to stiffen only the small inner spring — usually replaceing it, as there is not much room to add spacers here. (Sorry the article in July '74 *WTN* was not clearer about this.) Although suitable replacement springs for governor (not to mention certain other ones used on car) may be difficult to find, it is sometimes helpful to check the spring assortments available at most hardware stores.

Reassemble the rotor and replace it in shell. A short thick cotter pin can be used in place of retaining rivet if head is flattened slightly before use. Be sure that thrust washer under rotor (fibre or steel) is in place. If governor shaft still has excessive end play, a thin metal spacer (cut from sheet brass or perhaps aluminum) can be used along with the thrust washer. It will also help allow for slight wear at rotor tip.

Next Month: Overdrive "extras."

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Technical Advisors — send SASE for reply.
1914-16 6-40 — Fred Long, 3503 Allison, Brentwood, Md. 20722
1924-26 Hudson — Paul Loch, 2900 Main, Schnecksville, Pa.
1930-31 Hudson — Herb Fried, 2341 Pine Ridge Dr., Lafayette Hill, Pa. 19444
Essex 4&6 — Harold Everette, 425 Fairlawn Cr., Maryville, Tenn. 37801
1934-38 Terraplane — Alex Burr, 1 Hall St., Kennebunk, Maine 04043
1941-51 Vacumotive, Drivemaster, Supermatic — George Schmidt, 451 Elizabeth St., Mishicot, Wisc. 54228
1948-54 Models — Vernon Holt, 45 Franklin Rd., Mendham, NJ 07945 or Art Adams, 1004 Boston Post Rd., Guilford, Conn. 06437
1953-54 Jet, Italia — Wayne R. Graefen, 20105 E. Calora, Charter Oak, Ca. 91724
1955-57 — Glen Malme, 9337 Gotham, Downey, Ca. 90241
Speed Adv. — Jack Clifford, 102 Kalmus Dr., Costa Mesa, Ca. 92606