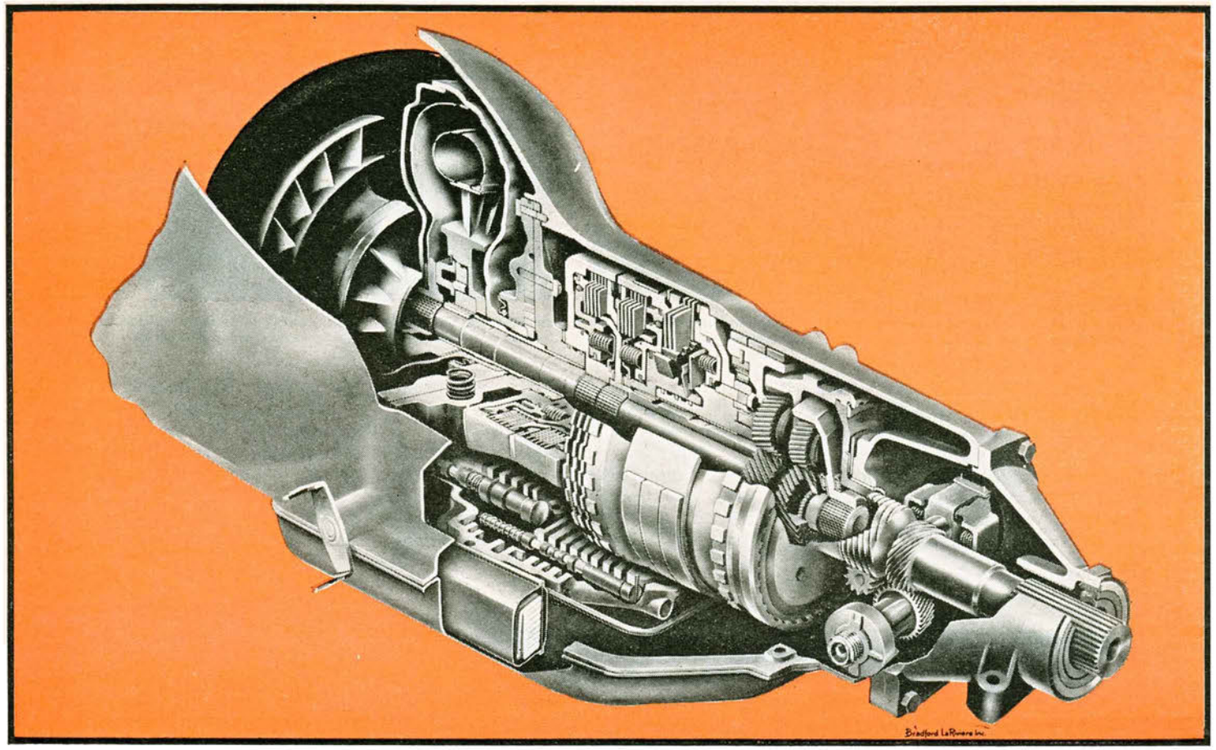


TWO NEW TRANSMISSIONS FOR GM CARS

Torque-Converter Automatics Are Replacing The Hydra-Matic

BY ALLEN HUNT

AUTOMOTIVE OBSERVERS have wondered through the years why General Motors didn't push more standardization of major mechanical components throughout the five car divisions—especially in the areas of engines and automatic transmissions. It seemed that there was a lot of unnecessary duplication of engineering effort and tooling there, where in some cases one division would have as many as three or four basic engines and two automatic transmissions that were exclusively its own.

Now it's beginning to happen. The first important steps were in the two new torque converter transmissions brought out for 1964 models in the Buick, Cadillac, Oldsmobile and Pontiac divisions. And, the use of these basic transmissions will be greatly extended next year. The new 3-speed torque converter (presently used on big Buicks and Cadillacs) will eventually replace the fluid-coupling Hydra-Matic in all standard-size Oldsmobile and Pontiac cars and will replace the Powerglide in heavier Chevrolet models. Probably, within two years, the new 2-speed converter (now used on Buick, Oldsmobile and Pontiac light models) will replace the Powerglide in the lighter Chevrolet cars. The day will come when two basic automatic transmissions will serve all GM lines. The standardization trend is gathering momentum.

All this makes the technical study of these two new transmission designs especially significant. That is, GM expects to produce millions and millions of these units in the next three or four years. We can assume that they combine the very best of everything Detroit knows about automatic transmissions to date. They should be the best compromise between performance, smoothness, cost, size, weight and service reliability that GM engineers can devise.

The new 3-speed transmission is being built by GM's Hydra-Matic Division in Detroit (formerly Detroit Transmission Division) for the '64 Buick and Cadillac senior models. In many ways there is nothing spectacular about the design (which, in itself, is significant). The torque converter unit is a very conventional 3-element type (pump, turbine, stator) that develops a stall torque multiplication ratio of about 2.1:1 at about 1950 rpm input speed. The planetary gearbox on the back gives additional step-up ratios of 2.48:1 in low gear and 1.48:1 in intermediate (ratios that are very close to what Chrysler uses in its TorqueFlite). Up-shift and downshift patterns are quite conventional. A die-cast aluminum case is used to reduce weight to 168 lb. (without oil), which compares favorably with other similar automatics in the industry with aluminum cases.

Probably the most important feature of this new GM 3-speed-and-converter is the arrangement of the clutches in the gearbox to get smoother shifts. It seems as if General Motors has done more work along this line than anyone else in the industry. Witness the elaborate triple-turbine Chevrolet and Buick converters of the late '50s, the unique secondary fluid coupling to smooth the shifts on the 4-speed Hydra-Matic, the late 3-speed Hydra-Matic that fills and empties the main coupling to smooth the shifts —all these gimmicks came out of GM Research. But all these gimmicks have proved to be too expensive, heavy, bulky and offer too many potential service problems in the field. GM wanted to find a simpler way to smooth the shifts.

They did it by using the age-old overrunning clutch in a new way. The principle is quite simple: When you shift gears on a planetary gearset, it is necessary that the torque load on one element be released, and the load be applied to another element. This requires a network of clutches. The reason some automatics are jerky when they shift, then, is that two types of clutches (usually a band type and multi-disc type) must be precisely timed to release and pick up their loads simultaneously. It's hard to get really accurate synchronization on a mass-produced design. One clutch may act just a fraction of a second before the other one, so there will be a speed-up or drag-down in engine speed before both are engaged.

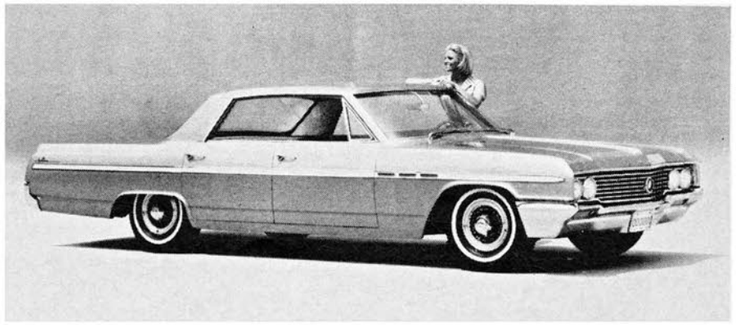
The new GM transmission solves this problem by releasing its torque load from an overrunning clutch on all forward shifts. The overrunning clutch is a simple sprag clutch arrangement. The little sprags swivel back and forth in a circular cage and thus expand or contract to catch or release a ring that goes around the sprags. The sprag clutch has more torque and shock capacity, and longer life, than the cam-and-roller type. Obviously there is no timing problem at all when the load is picked up from this type of clutch. It releases automatically, at the instant the other clutch picks up the load.

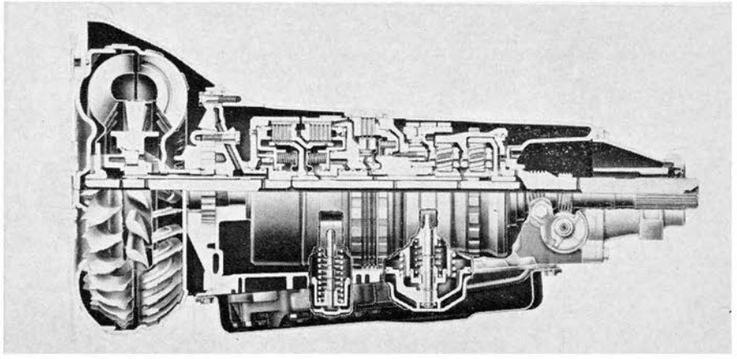
Another vital point: This other clutch on the new GM transmission is a spring-cushioned multi-disc design that runs in oil. The smoothness of the shifts can be precisely controlled by calibrating these clutches for a pre-determined amount of slip. The multi-disc clutch is well adapted to a large amount of slip because it has a large friction surface area over which to dissipate heat. GM engineers have designed quite a bit of slip into this new 3-speed. This, plus the use of the overrunning clutch to release the load, gives shifts that are probably smoother than those experienced with a step-gear transmission.

Another feature of the new transmission is the altitude compensation system. Look at it this way: An engine will lose about 3% of its power for every 1000-ft. increase in altitude, because of the thinner air. But normally the transmission line oil pressure, which determines the "stiffness" of the shifts, is sensitive to manifold vacuum or throttle opening which can't give the transmission any information as to the air density change. The result is that the shifts feel more jerky when the engine is putting out less torque at increased altitudes. The new transmission uses an aneroid bellows in the shift modulator mechanism that expands and contracts with changes in altitude, thus modifying the spring load against the valve. Now the shifts feel the same under all conditions.

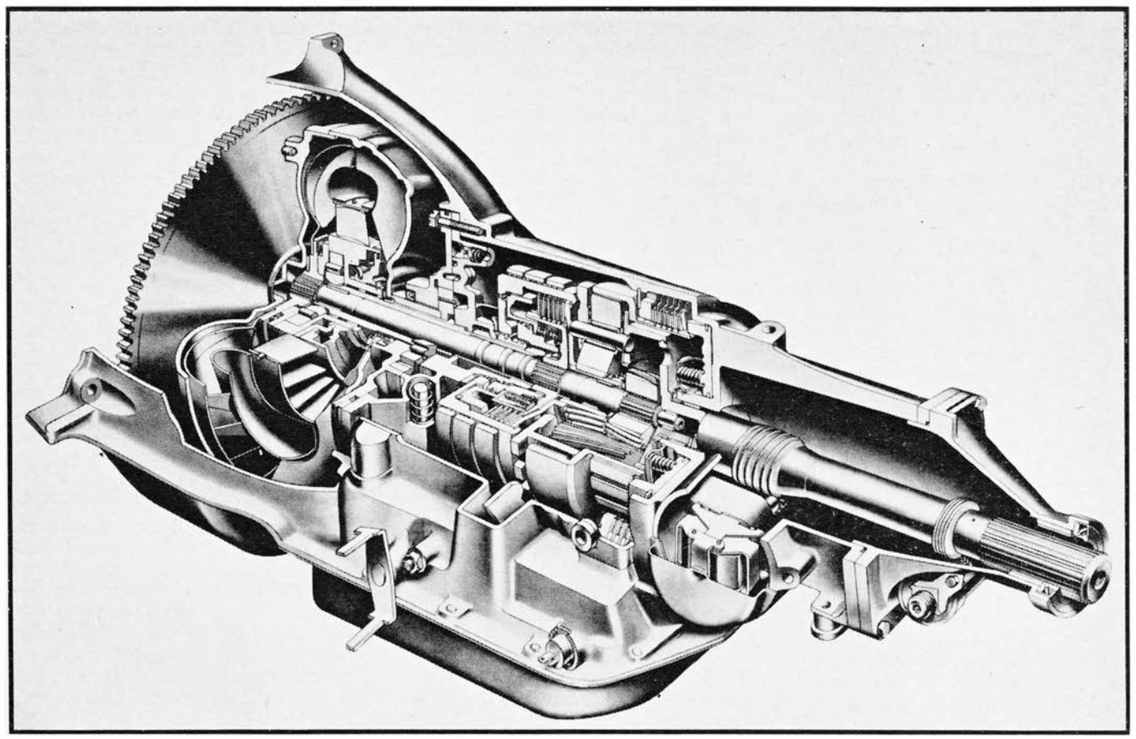
Other features on the new 3-speed: The new "counter-phased" planetary gears have staggered mesh patterns to damp out vibrations and gear whine. There is improved water-cooling of transmission oil and better oil filtration via a paper strainer. There is a new kickdown system that uses an electrical switch and solenoid to shift the gears, rather than the old mechanical linkage of rods and levers. It's much more accurate, long-lived and responsive.

The trend in the industry right now is away from the 2-speed-plus-torque converter in all sizes of cars. Both Ford and Chrysler have recently replaced 2-speed converters with improved 3-speed units for light cars and never did try to get away with only two forward speeds in heavy cars, as Chevrolet has done for years. It is felt throughout the industry that three speeds are needed to give quick ▶





SECTIONED SIDE view of 3-speed torque converter (below) for bigger Buicks and Cadillacs shows main oil pump in front, contoured blades in stator wheel for torque multiplication ratio of 2.1:1 at stall. Buick LeSabre (above) uses smaller automatic with 300-cu. in. V-8.



FOR LIGHTER cars such as Special, Tempest and F-85, Buick-built 2-speed torque converter is beefy enough to withstand over 300 cu. in.

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getaway from a standing start and still leave a reasonably close intermediate gear that will carry the car up to 70 mph or more for passing on the highway. GM would seem to be flying in the face of destiny with its new 2-speed.

But GM has a gimmick: It's using a variable-pitch stator in the converter which gives somewhat the same effect as an intermediate gear, when the driver floors the throttle to change the pitch. The pitch is changed by an electrical solenoid when the throttle reaches the three-quarter position. This switch to a high stator blade angle "loosens up" the converter, lets the engine speed up several hundred rpm and thus develop more torque. At any car speed above 12 mph there is substantially more rear wheel thrust in the high pitch angle. What the engineers have done is to design a very "tight" converter with low pitch on the stator. Under these conditions it has a full-throttle stall torque ratio of 2.7:1 at an engine input speed of only 1600 rpm. This results in an extremely responsive transmission under normal driving conditions and one that gives good gas mileage and little sensation of engine overspeeding on part-throttle acceleration. With the stator in high pitch, the stall torque ratio is down to 1.9:1 at an engine speed of 2300 rpm. The converter then becomes very "loose." At speeds above 12 mph, the forward thrust on the car is greater in high pitch.

There is another clever feature of this new converter: A tight converter has a great tendency to creep when the car is standing still with engine idling, but in this new design the engineers have utilized the convenience of the electrical switch mechanism on the throttle linkage (used for kick-down and pitch change) to automatically switch the pitch to high angle when the engine is idling. This loosens up the converter and reduces creep. Then, as soon as the throttle is cracked open, it returns to low pitch.

This variable-pitch stator arrangement is used by Buick and Oldsmobile for their lighter cars. Pontiac uses this basic transmission for the 115-in. wheelbase Tempest. But Pontiac has chosen not to go with the variable-pitch stator. Instead it compromised on a fixed stator angle which would give acceptable tightness for quick breakaway acceleration, without excessive creep at idle. Pontiac engineers seem satisfied with the 2-speed performance in this guise (although Buick and Oldsmobile engineers obviously are not).

The low gear multiplication ratio on the new 2-speed transmission is 1.76:1. This is just about the same as the 2-speed Powerglide at Chevrolet. This low gear will carry up to around 65 mph before upshifting with full throttle and can be kicked down below 58 mph. This gives a fairly decent spread of torque multiplication, especially when combined with the variable-pitch stator. (Note: The pitch is switched at three-quarter throttle opening, whereas the throttle has to go to the floor for the kick-down. Thus probably 95% of the time on the highway just the pitch-switch will do the job.)

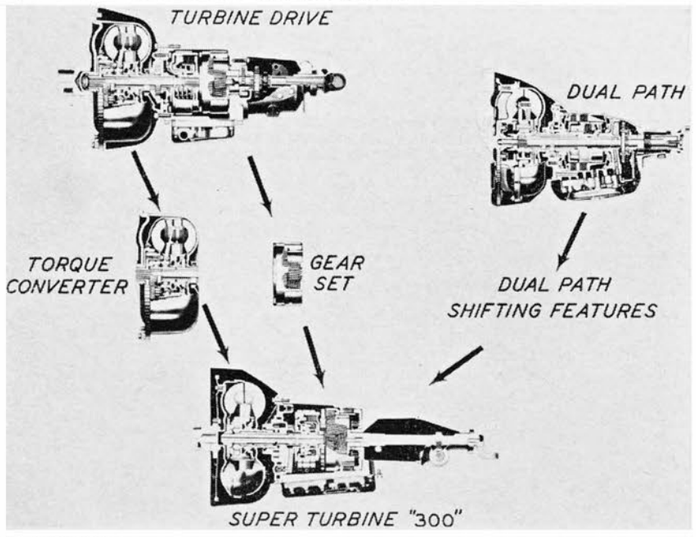
The layout of the planetary gearing on this 2-speed made it impractical to shift gears by picking up a torque load off an overrunning clutch with a multi-disc clutch. A band-type clutch has to be released and a multi-plate engaged to shift into direct drive. This could mean a rough shift, if this wasn't a very special type of band clutch. It's called a "double-wrap" type. In effect it's a self-energizing band clutch, similar to a car brake that utilizes its own friction to press the lining harder against the drum. But where a self-energizing brake has a "power factor" of 2 or 2.5:1, the double-wrap band clutch can apply five times more force in the major load direction (with a given clamping force) than when holding in the opposite direction. It acts almost like an overrunning clutch in operation. As soon as the multi-disc clutch relieves the torque load on the bands, it literally pops off. By properly calibrating the action of the bands and clutch, and by using the right friction materials and applying forces, the GM engineers have gotten very smooth shifts from this new 2-speed.

Other features of the new transmission: Extensive use of aluminum has held total weight to 130 lb. (less oil). This is heavier than Buick's Dual-Path 2-speed of '61–63 (98 lb.), but is extremely light for a transmission capable of handling engines with well over 300 cu. in. displacement. The altitude compensation system, with the aneroid bellows, is also used on this smaller transmission. And, it is one of the first compact transmissions to feature water-cooling of the oil. It has been found that more careful control of internal operating temperatures can go far in extending the life of gears and friction materials.

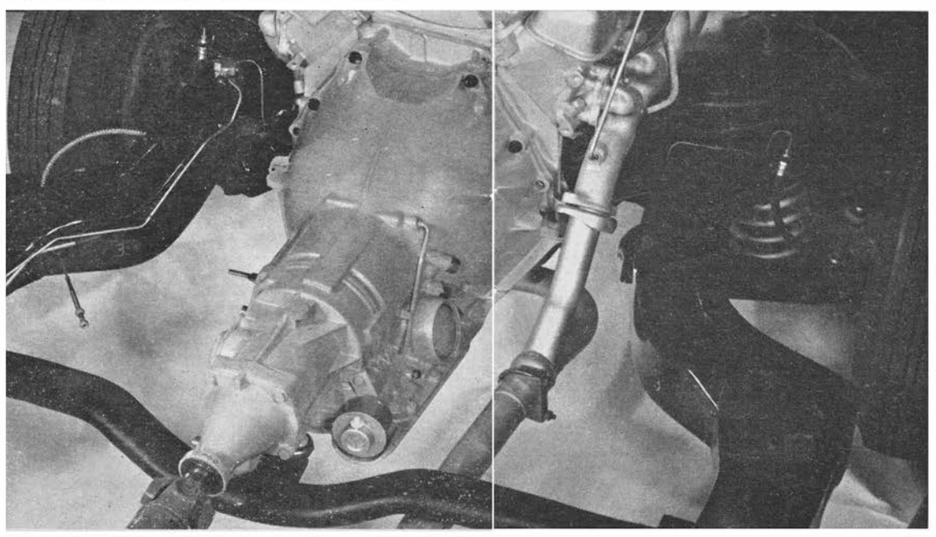
The electric switch and solenoid arrangement for control of kick-down and stator pitch already has been mentioned. Although this is more expensive than the old mechanical linkages, the increased response and reliability are apparently worth the extra cost. Also for reliability, the GM engineers have chosen a new helix angle for the planetary gear teeth to get more overlap and less gear noise.

So, there are the two new General Motors automatic transmissions. Buick is presently building the 2-speed unit for itself, Oldsmobile and Pontiac while GM's Hydra-Matic Division is making the big 3-speed. Undoubtedly the customers are going to see a lot more of these two transmissions in GM's future. In fact they may be the only GM automatics in another two or three years. ■

SUPER TURBINE 300 2-speed converter evolved from old twin-turbine Dynaflow and 2-speed Dual Path drive for compacts.



COMPACT aluminum construction holds weight of 2-speed to 130 lb.; aneroid compensates for altitude.



GENERAL MOTORS AUTOMATIC TRANSMISSION TYPES

Type	t. c. ratio	1st	2nd	3rd	4th ratio	Remarks
A	2.8/1.97	1.76	1.00	....	....	For V-6s, has variable pitch stator
A-1	2.45/1.80	1.76	1.00	....	....	For V-8s, has variable pitch stator
B	2.80	1.76	1.00	....	....	Same as A without variable stator
B-1	2.50	1.76	1.00	....	....	V-8 version
C	2.40	1.82	1.00	....	....	For 6-cyl. engines
C-1	2.10	1.82	1.00	....	....	For V-8s
C-2	2.60	1.82	1.00	....	....	Corvair transaxle version
D	2.15	2.48	1.48	1.00	....	Buick, Cadillac
E	....	2.93	1.56	1.00	....	Has 1.14:1 Accel-A-Rotor t.c.
F	1.2	2.93	1.56	1.00	....	Pontiac Hydra-Matic
G	....	3.97	2.55	1.55	1.00	Cadillac, Pontiac 4-speed H-M

USAGE

Make, Model	Name of Automatic	Type
Buick Special, Skylark, LeSabre	Super Turbine 300	A
Buick Wildcat, Riviera, Electra	Super Turbine 400	D
Cadillac 60 Special, deVille	Turbo Hydra-Matic	D
Cadillac 62, 75	Hydra-Matic	G
Chevrolet	Powerglide	C
Chevrolet Corvair	Powerglide	C-2
Oldsmobile Jetstar, F-85	Jetaway	A
Oldsmobile 88, 98	Hydra-Matic	E
Pontiac Tempest, LeMans	Hydra-Matic	B
Pontiac Catalina, Grand Prix	Hydra-Matic	F
Pontiac Star Chief, Bonneville	Hydra-Matic	G