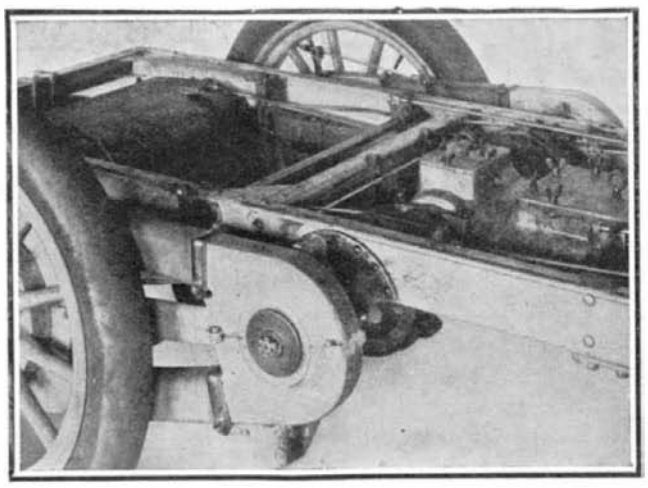
in the bottom ends of the levers, *H* and *K*. In the position shown it effectually locks these levers, and holds the gears in the neutral position. When it is desired to insert a gear in mesh, the operator first moves lever, *G*, to one side or the other of the H-shaped quadrant, and thereby releases at the bottom the lever that its latch, *J*, engages at the top. As soon as the clutch is thrown out the driver can then move *G* forward or backward in its slot until he has in mesh the gear desired. To bring into play the other gear set he must, after releasing the clutch, slip the lever, *G*, through the gate, or opening in the H-shaped quadrant, and thereby cause the latch, *J*, to lock into the other short lever, *H*, which is at the same time automatically released by the pin, *M*, while its twin is locked. Thus, it will be seen that there is a double interlock on this car, a fact which should make it extremely difficult for the novice to get into trouble while shifting the gears. The rear axle and countershaft construction is shown in one of the photographs. As already stated, the countershaft revolves on Hess-Bright ball bearings, and these are placed in the drum, *Y*, directly beneath the driving sprocket, which is attached on the six studs shown. The brakes are both of the contracting type, the foot brakes being applied upon drums which carry the driving sprockets, as can be plainly seen, while the emergency brakes, worked by the lever, *F*, are applied upon sprocket drums on the rear wheels. These drums are internally notched with ratchet teeth, and the pawl, *Z*, can be dropped into engagement with them to stop the car from running backward down hill. Last year this device was applied in a similar manner, except that the ratchet teeth were external instead of internal. The reverse is interlocked with the pawls, so that these cannot be engaged when the car is being backed. Perfectly straight, drop-forged radius rods, the rear ends of which completely encircle the rear axle, are employed on the new model Thomas cars. The construction is very substantial, and the car is one of the best-arranged machines used with a final chain drive.



PROTECTIVE CHAIN CASING ON THE LOZIER TOURING CAR.

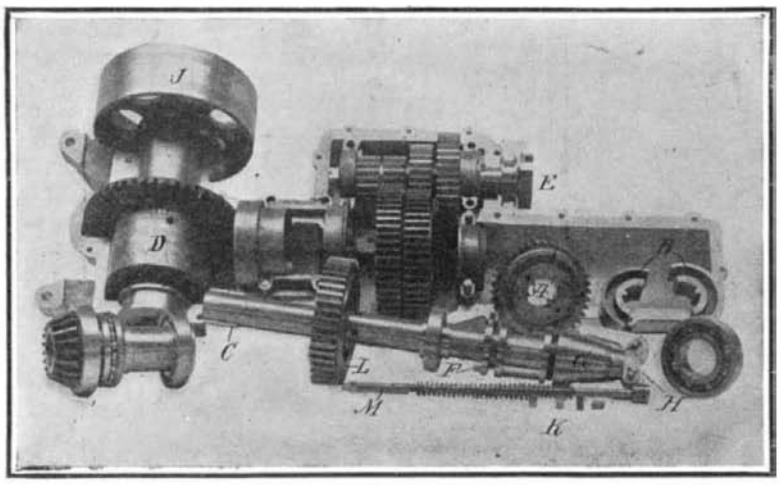
This is one of the much-needed improvements on cars employing the double chain drive. The countershaft of this car is also fitted with a separate water-cooled band brake near each end.

THE LOZIER PROTECTED DRIVE CHAIN.

One of the great disadvantages of the double side-chain drive over the drive by propeller shaft and bevel gears, is that in the former case the chains are near the wheels, where mud and dirt can splash upon them, and where, as a rule, no protection is given them. An improvement on the 1907 40-horse-power Lozier touring car is shown herewith. This consists in the protective casing for each chain, which completely incloses it and keeps off both dust and mud. The casing is composed of two aluminium castings, which surround the sprocket on the countershaft and the sprocket on the wheel respectively. These two castings are connected by a straight central supporting member of rectangular cross section, while rubber tubing (also rectangular in cross section) surrounds the chain, and connects the aluminium castings at the top and bottom. These rubber connections are clamped to the castings in such a way as to make a tight joint. Being flexible, they allow for any movement of the countershaft relative to the rear axle. The protection is very complete, and adds greatly to the life of the chain as well as to its quiet running. Another feature of this car is the fitting of separate brakes near each end of the countershaft, just inside of the frame. These brakes are connected to the pedal through an equalizing device, and they are water-cooled, being fitted with water jackets supplied from a special tank.

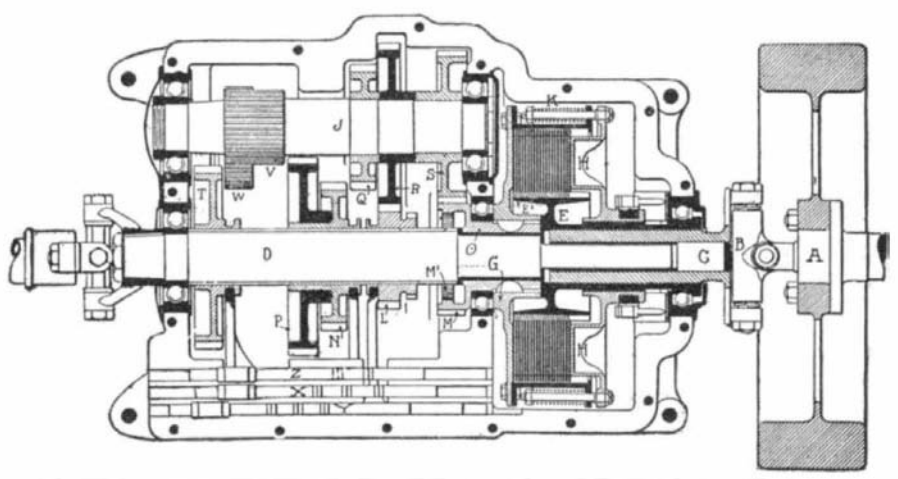
THE POPE-TOLEDO COMBINED CLUTCH AND TRANSMISSION.

The photograph and line drawing reproduced herewith give a good idea of the new combined clutch and transmission, which is used as a separate unit on the Pope-Toledo 40-horse-power touring car. All the gears and shafts are of chrome nickel steel, and every moving part is fitted with Hess-Bright ball bearings. Besides the carrying of the clutch in the forward part of the gear case, another feature of this transmission is that the direct drive is obtained upon the third speed by sliding gears *L I* to the right, so that *I* meshes with the internal gear *M*, while the fourth speed, which is used only under the best conditions, is had through *M S R L* as shown in the diagram. The drive on the first and second speeds is through *M S V P* and *M S Q N*, while the reverse is obtained by sliding *T* into mesh with the intermediate pinion *W*, the drive then being through *M S V W T*. The clutch is formed of nineteen soft-steel disks, *E'*, which are carried on the special carrier, *E*. This carrier is keyed to the hollow shaft that connects with the universal joint, *B*. Twenty hard-steel disks supported at their peripheries on another carrier, *G* (which terminates in the gear *M*), form the other part of the clutch. The first-mentioned disks are attached to their carrier, *E*, by means of six keys, arranged radially around the carrier. These disks are 10⅛ inches in diameter. The other disks, which are 10¾ inches in diameter, are attached to their carrier, *G*, by four series of slots placed 90 degree. art around their peripheries, and through which pass bolts carrying spring washers between the disks, to assist in separating them when the clutch is disengaged. On the extreme outside of the disks are eight springs, *K*, placed radially at equal intervals. These act through the pressure plate, *H*, to press the disks together. By placing them on the outside of the disks, and causing them to work through this pressure plate, all the disks are compressed uniformly throughout their entire surface. Besides a universal joint, *B*, between the crankshaft, *A*, and the hollow stub shaft around *C*, there are two other universal joints between the transmission and the countershaft, which is located some distance farther back on the frame as an entirely separate unit. This makes it possible to use short driving chains, and is a distinctive feature of the new Pope-Toledo car. The entire power transmission of this machine is, therefore, quite different from that ordinarily used. The idea of incasing the clutch with the gears is a good one, as is also the plan of placing the countershaft as near the rear wheels as possible. The Pope-Toledo engine of 4⅞ bore by 5¼-inch stroke is rated at 40 horse-power. It is very similar to the De Luxe engine illustrated on page 24, as it has the same walking-beam valve mechanism, and the cylinders are cast in pairs and provided with copper water jackets. A peculiar arrangement is noted in the oiling of this engine, which is accomplished by pressure feed, from a small oil tank placed beneath the floor, and having a pressure of 5 pounds per square inch, supplied by a hand-operated air pump between the individual front seats. There is also a plunger for forcing oil directly into the crankcase. A convenience with regard to the carbureter is that it can be primed by pressing a button arranged beneath the radiator at the front of the car. The fuel is forced by air pressure from a double 25-gallon tank at the back of the car to a 5-gallon running tank on the dash, in which the gasoline is kept at a certain level automatically. Should it fall below this level, an alarm is sounded.



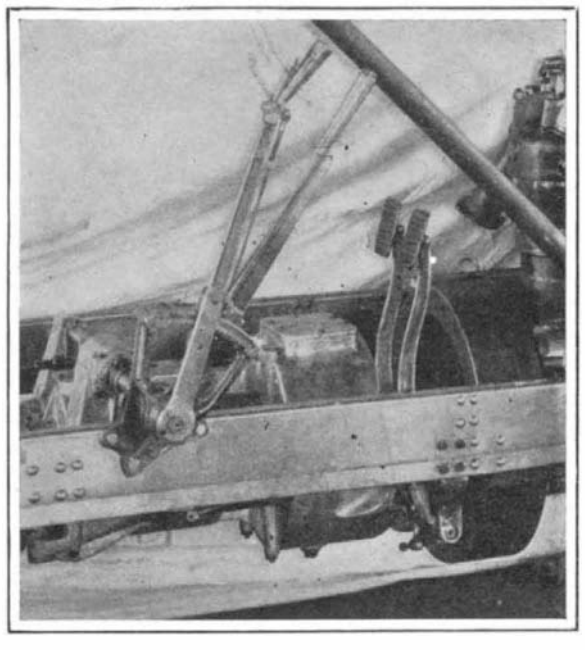
THE BERKSHIRE INDIVIDUAL CLUTCH TRANSMISSION.

A. One of the gears with clutch inside. *B*. Expanding clutch shoes. *C*. Keys on hollow shaft for bevel driving pinion. *D*. Differential and large bevel gear. *E*. Universal joint for drive shaft from engine. *F*. Shifting collar for sliding hollow shaft, *C*. *G*. Shifter for tapered pin, *M*. *H*. Pivoted end piece for working shifter, *G*. *L*. One of the four gears with clutches that slide on shaft, *C*. *K*. Four tapered blocks that are expanded by *M* through holes seen beside *L* and that thus serve to expand shoes *B*.



CROSS-SECTION OF POPE-TOLEDO COMBINED TRANSMISSION AND CLUTCH.

A. End of crankshaft carrying flywheel. *B*. Universal joint. *C*. Bearing of main transmission shaft, *D*, in hollow stub shaft that carries clutch disk drum, *E*. *E'*. Driving disks of clutch. *F*. Rear shaft extending to countershaft. *G*. Driven drum of clutch. *H*. Pressure plate of clutch. *I*. High-speed gear that fits in internal gear, *M'*. *J*. Lay shaft. *K*. Clutch springs. ●. Sleeve carrying master pinion, *M*. *X*, *Y*, *Z*. Notched shifting-gear rods.



TRANSMISSION AND OPERATING LEVERS OF POPE-TOLEDO TOURING CAR.

The multiple-disk clutch is in a compartment at the front end of the gear box. The countershaft for the double chain drive is placed by itself some distance back of the gear box, thus allowing short chains to be used.

A NOVEL INDIVIDUAL CLUTCH TRANSMISSION.

The accompanying photograph shows the transmission of the Berkshire car taken apart to show the interior construction. The top half of the case is simply removed to show the interior. At one end of the top half of the case is a raised housing. Dependent from the inside of this housing are the shifting forks, which in turn are connected by a shaft to the operating lever on the side of the car. The shaft, *E*, is connected direct to the engine. Upon this shaft are keyed the steel gears which mesh into the phosphor bronze ring gears, *B*. Each of these ring gears are supplied with internal expanding frictions, the two halves of which are shown at *B*. These two halves are again shown placed in position at *A*. The sliding shaft, *C*, upon which this ring gear is placed moves longitudinally, when placed in position in the case, through all of these gears. At a point in this movable shaft, four square holes are made, which open into a hole drilled longitudinally through the entire length of the shaft. These holes are shown beside *L*. The steel wedge pins, *K*, are inserted in these square holes, *L*, and when located under any of these ring gears, are forced outward by the internal expanding wedge *M*, which is operated by a side lever on the car, in connection with the depending shifting forks, which are connected with *F* and *G*. The forward motion of the lever operates *F*, which is fast to the shaft and moves the shaft longitudinally under the desired gear. The backward movement of the lever operates forks connected with the tapered cone, *G*, and forces it under the fingers, *H*, which are fulcrumed on

(*Continued on page 53.*)

charge. A slight comparison of the duties of this valve with the crankshaft of the same engine is interesting. The area of the 5-inch piston is approximately 20 square inches, while the area of the exposed surface of the valve is but a little over one-tenth this amount, being less than 2¼ inches. The bearing surface of the valve shaft extends the full width of the cylinder, whereas the bearing surface of the crankshaft does not total one-half of this amount, because of the crank-sides and crankpins which must be provided for. From this it will be seen that the work done by the valve is but 1/20 the work done by the crankshaft, and yet to provide ample packing surface, the valve diameter and consequent surface is 30 per cent greater than the crankshaft diameter. From this comparison, as well as from the results given in practice, it is readily seen that the life of the valve should be very long under normal usage.

Experiments have been made with tapered valves fitting their bushings as does an ordinary stopcock, but trial of both kinds has convinced Mr. Duryea that even the slight added cost and complexity of the tapered form is not necessary to secure the desired results.

In service, the rotary valve engine runs almost like a steam engine. The mechanical operation of the inlet permits perfect admission of the attenuated charge admitted at low throttle, and secures a wide range of speed because of this smooth running at low speeds, as well as because of the lack of reciprocating parts, which clatter and pound badly at high speeds. The crankshaft bearings are made quite large, and the connecting rods are forged and of so strong a design that high speeds cannot damage them.

The prediction is freely made that this invention is one of the most marked improvements in the four-cycle gasoline automobile motor that have been made in recent years. Mr. Duryea has several patents pending upon this device.

THE 50-HORSE-POWER NORTHERN ENGINE.

(*Continued from page 25.*)

arate steel pan. Nipples screwed into the cylinders just above the highest point of piston travel carry horizontal pipes with three vertical outlets, the center one of which carries a spark plug, the right-hand one a priming cock, and the other a patent relief valve for each cylinder. The relief valves are all connected together so that the chauffeur can, by pulling a handle, put them all in operation when turning over the engine. These valves only open when the compression occurs, and as soon as an explosion takes place, they instantly close.

The motor is started by a long lever having a pawl that engages the teeth of a ratchet wheel on the crankshaft. The movement of the lever in starting the engine automatically retards the spark. The two-to-one gears are shown incased at *T*, and are used as a water pump to force the cooled water received from the bottom of the radiator through the large pipe, *W*, leading to the bottom of the water jackets. The bracket for the fan belt pulley, seen at the front end of the engine, is mounted on a vertical spindle that can be raised or lowered by turning the star wheel on top. Thus the fan belt can be easily and quickly tightened. The cylinders of the Northern engine are slightly offset, which gives a more direct thrust on the working stroke.

A SUCCESSFUL FRICTION-DRIVE AUTOMOBILE.

(*Continued from page 26.*)

tenber engine rated at 40 H. P. at 1,000 R. P. M. The timer is shown at *T*. *P* is one of the connections between the timer and the base of the steering column, *V*, for advancing the spark by means of one of the levers that travel over the stationary segment in the steering wheel. The motor is provided with an 8-feed mechanical oiler, which efficiently lubricates it.

A NOVEL INDIVIDUAL CLUTCH TRANSMISSION.

(*Continued from page 29.*)

the end of the sliding shaft, *C*, the ends of which press the internal expanding wedge, *M*, forward, thus causing the four wedge pins, *K*, to protrude beyond the periphery of the shaft, *C*, opening the frictions, *AA*, against the internal wall of the bronze ring gear, *B*. This action makes the whole mechanism integral. To change the speed the sliding shaft is simply located under any gear desired and the operation repeated. *D* is the differential from which the jack shaft, *J*, protrudes from either side, to the sprockets. The reverse is accomplished by an intermediate gear which is located in a pocket at the bottom of the case under another gear (which is shown as not in mesh and on the shaft, *E*.)

THE GROUT 35-HORSE-POWER CHASSIS.

(*Continued from page 31.*)

tion is by accumulators and a single spark coil. The high-tension distributor is combined with the commutator, *C*, which is operated by a lever in the steering wheel. The muffler appears at *M*. The engine and transmission are mounted on an angle steel sub-frame, as shown.

Levers *A* and *B* operate the three-speed progressive sliding-gear transmission and the expanding emergency brakes on the rear wheels. The former lever is connected through the horizontal lever, *D*, with the sliding rod, *R*, that extends into the gear case, and shifts the gears, while the latter lever, *B*, when drawn toward the driver, applies expanding brakes in the rear wheels. The pedal, *E*, operates the contracting brakes on the rear wheel hubs, while the pedal, *F*, controls the clutch, which is of the ordinary leather-faced cone type. There is a large universal joint, *U*, between the clutch and the gear box, and the countershaft is provided with Oldham universal couplings between the gear box and the frame. One of the driving sprockets on the countershaft is seen at *J*. A cylindrical gasoline tank of 15 gallons capacity is placed under the front seat, and the pipe, *P*, extending from its lowest point to the carbureter, feeds the latter by gravity.

THE NORTHERN FOUR-CYLINDER 50-HORSE-POWER CAR.

(*Continued from page 34.*)

son, the Northern Motor Car Company has placed on the market a 50-horse-power car embodying all the essential features of the air control. Clutch and air control features remain practically the same as last year, with the exception that the parts are increased in proportion to the larger car, which is rated at 50 horse-power.

It will be noticed that the entire control is placed on the steering column, and that all side levers are omitted. The gear-shift lever is placed horizontally just below the steering wheel, and the small lever which operates the shift gears controls the clutch. A slight turning motion of the hand grip on this lever throws in or releases the clutch. It will be seen that practically the same motion that shifts the gears operates the clutch at the same time. The reverse operation is taken care of with the right foot by pressing on a pedal projecting from the steering column. This reverse position is interlocked in such a way that the reverse can only be operated in a certain position of the gears. The transmission is placed on the rear axle. It is very compact, and runs on roller bearings of the Timken type. Easy adjustment and accessibility are marked features of this arrangement. Ball bearings are provided for the steering spindles as well as the worm and segment mechanism, which renders steering very easy.

Special attention is directed to the pivotal rear platform spring, which permits of either of the rear wheels passing over an obstruction without imparting any shock to the car frame. It will be

(*Continued on page 56.*)