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NOMOGRAPHS FOR ENUMERATION OF CLUTCHING SEQUENCES ASSOCIATED WITH EPICYCLIC-TYPE AUTOMATIC TRANSMISSION MECHANISMS

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يقدّم هذا البحث طريقه جديده لتعداد كافة تتابعات تعاشيق التروس الممكنه لآليه ترسيه كوكبيه بأستعمال مخططات النوموغراف الكيناماتيكيه للمجموعات ألترسيه كوكبيه-النوع. ومن هكذا مخططات أمكن التعبيرعن السمات الكيناماتيكيه للآليات الترسيه الكوكبيه بدلاله النسب السرعيه لازواج التروس المكونه لها. من مخطط نوموغرافي واحد يمكن تخمين السرع الدورانيه لكافة الصلات المكونه للآليه الترسيه ومقارنتها مباشرة" دون تحديد مقاسات التروس أبتداء". وبالاضافه الى ذلك ، يمكن ترتيب السرع الدورانيه تنازليا" ببساطه دون أستخدام التقنيه الخوارزميه او تقنية الذكاء الصناعي الستخدمتين سابقا". بعد ذلك، تم تطوير طريقه لتعداد كافة تتابعات تعاشيق التروس المصاحبه لآليات نقل الحركه المكونه من كيانيين بنائيين ترسيين أو أكثر. وللتحقق من موثوقية الطريقه، تم تطبيقها على مجموعتين ترسيتين لنقل الحركه، يتوفر لاحدهما حل كامل في الادبيات المنشوره ويتوفر للاخرى حل جزئي. أثناء ذلك، تم تسليط الضوء على نتائج غير مكتمله مدونه في الادبيات السابقه كما تم أستكشاف السبب الحقيقي لعدم الاكتمال هذا. وقد أظهرت النتائج المستحصله بالطريقه الحاليه انها أكثر فاعليه لتعداد كافة تتابعات تعاشيق التروس الممكنه لآليه ترسيه كواكبيه.

A new methodology for the enumeration of feasible clutching sequences for a given epicyclic gear mechanism (EGM) is presented using the kinematic nomographs of epicyclic-type transmission mechanisms. From such nomographs, the kinematic characteristics of an epicyclic gear mechanism can be expressed in terms of the gear ratios of its gear pairs. From a single nomograph, the angular velocities for all of the coaxial links can be estimated and compared directly without specifying the exact size of each gear. In addition, the angular velocities can be arranged in a descending sequence without using complicated artificial intelligence or algorithmic techniques. Then, a procedure for the enumeration of feasible clutching sequences associated with a transmission mechanism composed of two or more fundamental gear entities (FGEs) is developed. The reliability of the methodology is established by applying it to two transmission gear trains for which solutions are either fully or partially available in the literature. In the process, an incomplete in the results reported in previous literature is brought to light. And the root cause of this incompleteness is explored. The present methodology is judged to be more efficient for enumeration of all feasible clutching sequences of an EGM.

1. INTRODUCTION

Most automatic transmission mechanisms employ epicyclic gear trains (EGTs) to achieve a set of desired velocity ratios. Typically, the central axis of an EGT is supported by bearings housed in the casing of an automatic transmission. The EGT and the casing form a fractionated mechanism called an epicyclic gear mechanism (EGM). Figure 1 shows an EGM employing the Simpson gear set as the ratio-change gear train. This gear set is, perhaps, the most popular transmission gear set. It has been developed by nearly all automotive manufacturers as three- and four-velocity automatic transmission.

In an EGM, the velocity ratio is defined as the ratio of the input shaft velocity to the output shaft velocity. Various velocity ratios are obtained by using clutches to connect various links to the input power source and to the casing of a transmission gearbox, respectively. Typically, a rotating clutch is used for connecting two rotating links and a band clutch is used to fix a link to the casing. In Figure 1 rotating and band clutches are denoted by C and B, respectively. Also it is always possible to achieve a direct drive by locking all the links in the EGT together such that they rotate as a single link. The velocity ratios selected for a transmission are tailored for vehicle performance and fuel economy. Typically, they include a first gear for starting, a second and/or third gear for passing, an overdrive for fuel economy at road speeds and a reverse.

A table depicting a set of velocity ratios and their clutching conditions is called a clutching sequence. Table 1 shows the clutching sequence of the transmission shown in Figure 1, where an X*i* indicates that the corresponding clutch is activated on the *i*th link for that gear.