Emirates Journal for Engineering Research, 12 (3), 47-55 (2007)

(Regular Paper)

KINEMATIC NOMOGRAPHS OF EPICYCLIC-TYPE TRANSMISSION MECHANISMS

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(Received April 2007 and accepted September 2007)

يقدّم هذا البحث طريقه جديده لحساب النسب السرعيه لآليات نقل الحركه ذات التروس الكواكبيه. تم تمثيل النظام بالاعتماد على النظريه الرصينه لتمثيل الانظمه بالمخططات، ومنها أمكن الاهتداء الى الكيانات البنائيه الترسيه الاساسيه. وقد قاد التعرف على هذه الكيانات البنائيه الى أنشاء المخططات النوموغرافيه آليا" بطريقه منهجيه منظمه. يتحرى هذا البحث ، بأستخدام المخططات النوموغرافيه، السمات الكينماتيكيه المقترنه بمختلف الكيانات البنائيه الترسيه الاساسيه، ومنها أمكن التعبير عن النسبه السرعيه الكليه لآليه ترسيه كوكبيه بدلالة نسبة أسنان ازواج التروس المكونه لها. أن الميزه الاساسيه للمخططات النوموغرافيه هي بساطتها. من مخطط نوموغرافي واحد, يمكن أن نبصر السرع الدورانيه لكل الاجزاء الدوّاره. و يمكن الحصول على التعابير ألرياضيه لكل النسب السرعيه لكيان بنائي ترسي و/ أو لآلية ترسيه كوكبيه بالمشاهد ه فقط دون ألحاجه إلى حل المعادلات مرارا" وتكرارا" ودون تحديد قياس كل ترس ابتداء". بالاضافه إلى ذلك ، فأنها تعطي رؤيا أفضل لتأثير الكيانات البنائيه ألترسيه الاساسيه ومقاسات التروس على ألنسبه السرعيه الكليه لآلية التروس الكواكبيه ، وهذا مفيد جدا" في التعرف على تتابع تعشيق التروس أثناء ألمرحله ألتصميميه لآليات نقل الحركه ذات التروس الكواكبيه.

A new methodology for the velocity ratio analysis of epicyclic-type transmission mechanism is presented. The well established graph theory is used to represent the system and then to detect the fundamental geared entities (FGEs). The identification of FGEs leads to automated construction of the kinematic nomographs in a systematic manner. Using nomographs the kinematic characteristics associated with various FGEs are investigated. Then, it is shown that the overall velocity ratio of an epicyclic gear mechanism (EGM) can be expressed in terms of the gear ratios of its gear pairs. From a single nomograph one can visualize the angular velocities of all the links of an EGM. The main advantage of kinematic nomographs is its simplicity. Also, algebraic expressions for all of the velocity ratios of an FGE or/and an EGM can be easily obtained by observation without the need to solve equations repeatedly and without specifying the exact size of each gear. In addition, it provides a better insight of the effects of the FGEs and their gear sizes on the overall velocity ratio of an EGM. This is very helpful in the identification of a clutching sequence during the design phase of an epicyclic -type transmission mechanism.

1. INTRODUCTION

Most automatic transmission mechanisms employ epicyclic gear trains (EGTs) to achieve a set of desired speed 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 EGM. Figure 1 shows an EGM employing the Simpson gear train as the multi-speed reduction unit.

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. Typically, they include a first gear for starting, a second and a third gear for passing, and a fourth gear for fuel economy at road speeds. A table depicting a set of speed 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. For example, when the mechanism is in the first gear, the rotating clutch C1 and the band clutch B1 are activated. Hence, link 4 is connected to the input power and link 1 is fixed to the casing.

Table 1. Clutching sequence of the mechanism shown in Figure 1

	Activated clutches			
Range	C1	C2	B1	B2
First	X4		X1	
Second	X4			X3
Third	X4	X3		
Reverse		X3	X1	