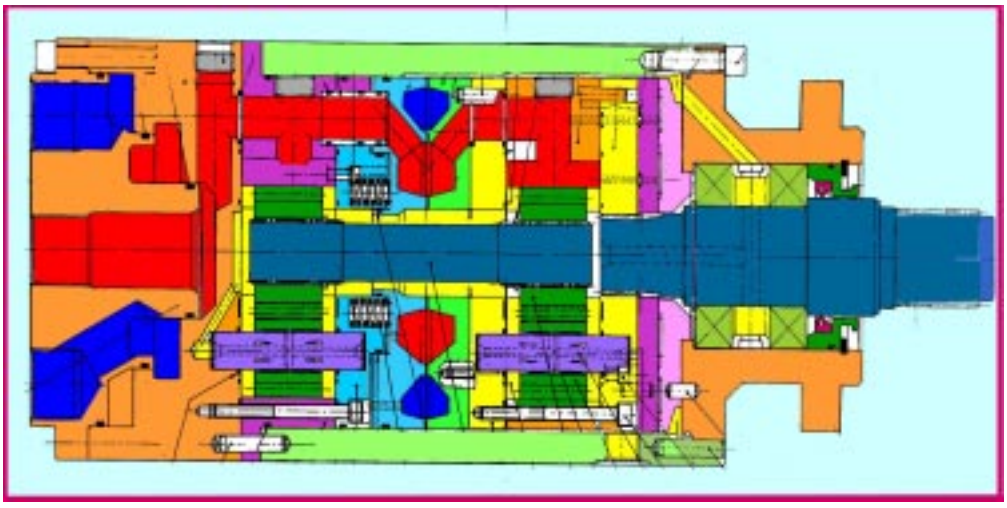
"GoldDrive"

Infinite Variable Speed Drive Consisting of Hydraulic Fixed Pumps & Motors



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"GoldDrive"-Infinite Variable Drive Consisting of Fixed Displacement Pumps & Motors.

Nahum Goldenberg.

(Patents: 88110932-6/F16H5/87-21415A/87-880712-4922804)

1. ABSTRACT

"**GoldDrive**" is an infinite variable ,bi-directional drive consisting of hydraulic fixed displacement pumps and motors. As a matter of fact "GoldDrive" is the hydraulic equivalent of the mechanical differential . The idea behind the development of "**GoldDrive**" is to overcome the limitation of starting torque . According to the traditional equation , torque is equal to power over speed and as a result , we need an infinite amount of torque to start a load at zero output speed . The solution is Slippage , slippage of electrical , mechanical , hydraulic and pneumatic transmissions. "**GoldDrive**" enables us to achieve maximum efficiency and starting torque at zero output speed without slippage .

INTRODUCTION

"**GoldDrive**" was developed by Nahum Goldenberg with result of the assumption that all four traditional drives, electrical , mechanic , hydraulic and pneumatic have similarities and only historical reasons lead us to separate the different drives instead of unifying units. Below one can see the similarities.

	Electric	Mechanic	Hydraulic	Pneumatic
Quantity	Coulomb	Length	Volume	Volume
Qty/Time	Current	Speed	Flow	Flow
Potential	Volt	Force	Pressure	Pressure
Power	I x V	F x v	p x Q	p x Q

As a conclusion I understood that like electric generator we have v-belt generator (drive wheel) , gear generator (driving gear) , fluid generator (hydraulic pump) and gas generator (air and gas compressor) . Same are the electric , mechanic, hydraulic and pneumatic motors. In the same manner we have the controls of voltage and current , force and speed , pressure and flow etc'.

Coming to the accessories like sealing , cooling , filtration , isolation , accumulators and more , I arrived to the mechanical , electrical , hydraulic and pneumatic differentials . Basically the mechanical differential is characterized by having one input and two outputs that the mathematical relation between them is :

$n_{in} = K (n_1 + n_2)$ where **k** is the gear ratio and n_{in} , n_1 and n_2 are the output speeds respectively. As flow $Q = n \times q$,we can express the hydraulic differential as $Q_{in} = n_1 \times q_1 + n_2 \times q_2$. In case we select $q_1 = q_2$ then the above equation becomes: $Q_{in} = q (n_1 + n_2)$. This equation is behind the development of "**GoldDrive**". The same can be considered for linear as well as for rotary motion . In both cases we can achieve infinite variable speed , bi-directional , using fixed displacement pumps , motors and actuators while starting torques and forces are at their maximum efficiency and nearly without slippage.

2. MAIN SECTION

Basically "**GoldDrive**" expresses the relative movement and speed between two hydraulic motors or actuators. Below you can see Figure – 1, the conceptual design of two linear actuators.

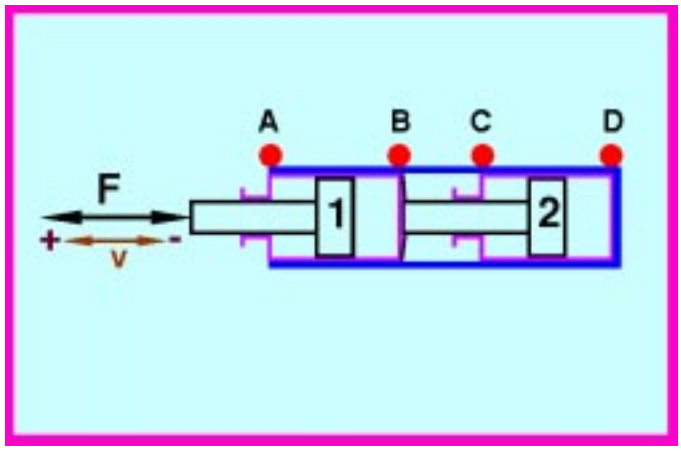

Figure – 1.

In Figure –1 , the force **F** acts on both actuators and by causing actuator 1 to move **(-)** direction while actuator 2 to **(+)** direction at same speed , the total resultant speed will be zero **(0)** at constant force **F**. Same will be achieved in case of rotary motion as it can be seen in Figure –2 below .

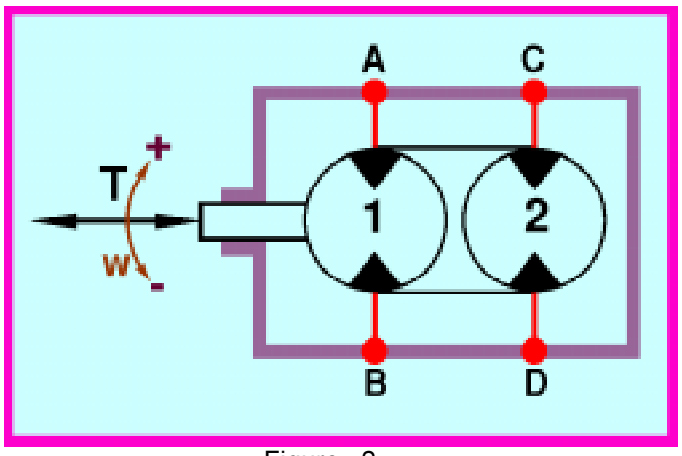

Figure –2 .

In Figure –2 , the torque T acts on both hydraulic motors and by causing motor 1 to run CW **(+)** and motor 2 CCW **(-)** at same speed , the total resultant speed at constant torque will be zero **(0)** . The main advantage of using such a differential drive is by having the ability to start linear and / or rotary motion without slippage . Remembering that torque $\mathbf{T}_{\text{torque}} = \mathbf{P}_{\text{power}} / \mathbf{n}_{\text{speed}}$ and when speed is zero , we need infinite amount of force or torque to start moving a load using traditional equation compared to the differential drive where we get constant force and / or torque at zero output speed.

3. How we vary the relative speeds.

In linear motion $\mathbf{F_1=p_1 \times A_1}$ and $\mathbf{F_2=p_2 \times A_2}$. As $\mathbf{A_1}$ is equal to $\mathbf{A_2}$ by construction and $\mathbf{F_1=F_2}$ by physical means , then $\mathbf{p_1 = p_2}$. In rotary motion $\mathbf{T_1=p_1 \times q_1}$ and $\mathbf{T_2=p_2 \times q_2}$. As we select $\mathbf{q_1}$ to be equal to $\mathbf{q_2}$ and $\mathbf{T_1=T_2}$ then $\mathbf{p_1 = p_2}$. In both motions $\mathbf{p_1 = p_2}$ neglecting flow pressure drops. By using the equation of flow through orifices $\mathbf{Q=C_d \times A \times (2g / \gamma)^{1/2} \times (\Delta p)^{1/2}}$ we can conclude that we can divide input flow to a spool valve and by changing the area ratio we can divide the flow proportional to the area ratio . This flow splitter will direct flow at **50%-50%** to both actuators or motors resulting zero output speed . Conceptual construction can be seen in Figure –3 on top right side. By moving the handle , in case of a manual control , we change the area ratio between oil passages and by that the flow proportionally to each actuator and / or hydraulic motor. In the following relations :

$$\mathbf{Q_1=CdxA_1(2g/\gamma)^{1/2}x(p_1)^{1/2} / Q_2=Cd(2g/\gamma)^{1/2} \times (p_2)^{1/2}}$$

And then $\mathbf{Q_1 / Q_2 = \sim A_1 / A_2}$. By moving the spool in one direction or to the other we divide the flow at any required ratio.

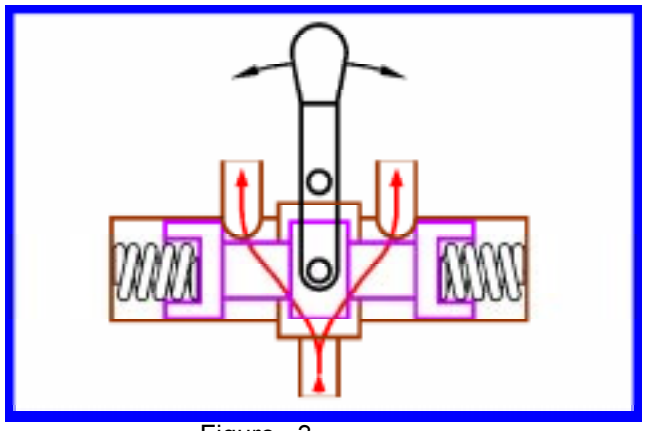

Figure –3 .

4. “GoldDrive” with mechanical differential.

In Figure –4 , below , an hydraulic circuit with a mechanical differential is shown .

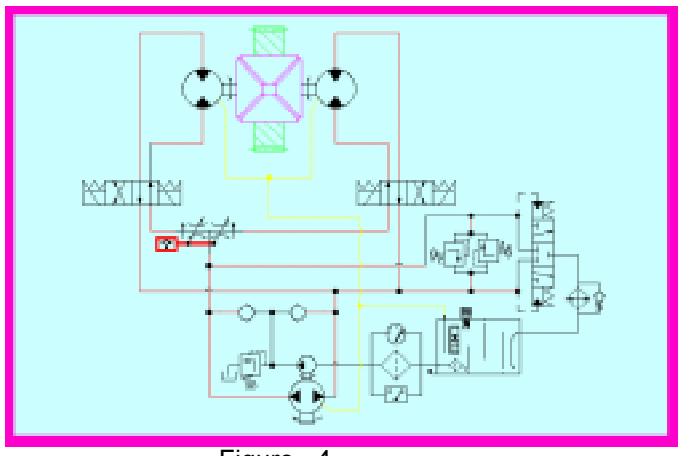

Figure –4 .

5. “GoldDrive” with hydraulic Differential.

In Figure –5 , below , an hydraulic circuit with an hydraulic differential is shown .

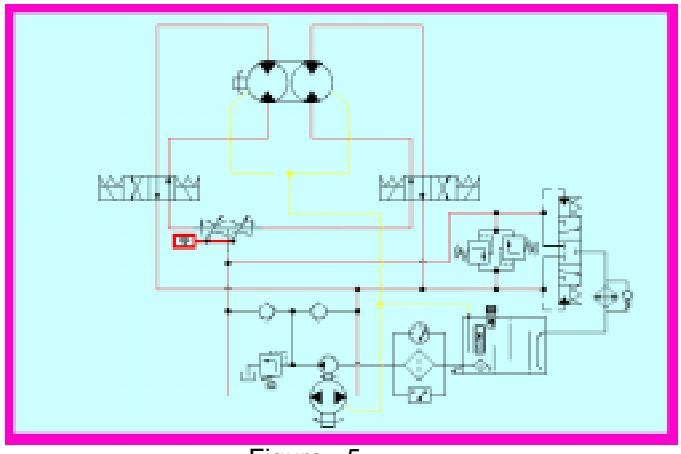

Figure –5 .

6. “GoldDrive as an automotive infinite …..variable drive with mechanic differential.

In Figure –6 , below , an automotive gearbox , infinite variable with mechanical differential is shown .

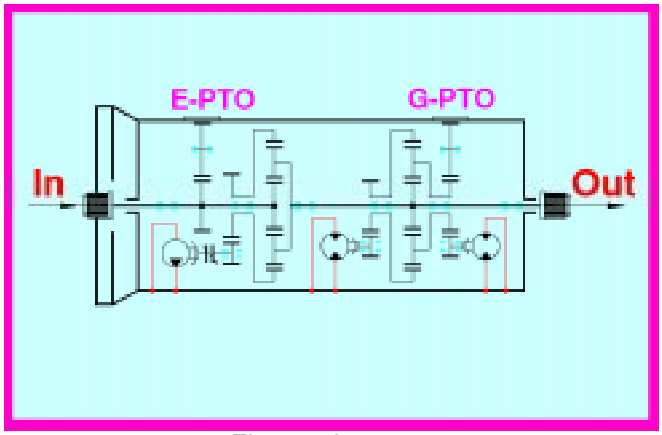

Figure –6 .

7. “GoldDrive” as an automotive infinite …...variable drive with hydraulic differential.

In Figure –7 , below , an automotive gearbox, infinite variable with hydraulic differential.

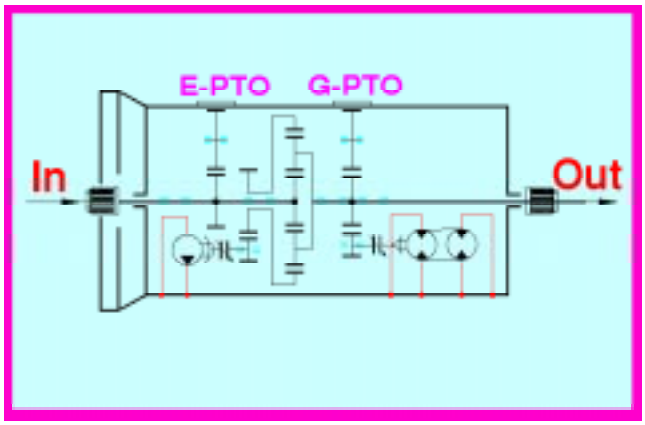

Figure – 7.

8. What are the advantages.

First we get constant torque at zero output speed. Second advantage is by not having slippage at zero output speed and third advantage is the ability to reach speeds of **+/- 2n** by running the two motors at the same direction (not one cw and second ccw where we get **+/- n** only) . Below are the two efficiency graphs.

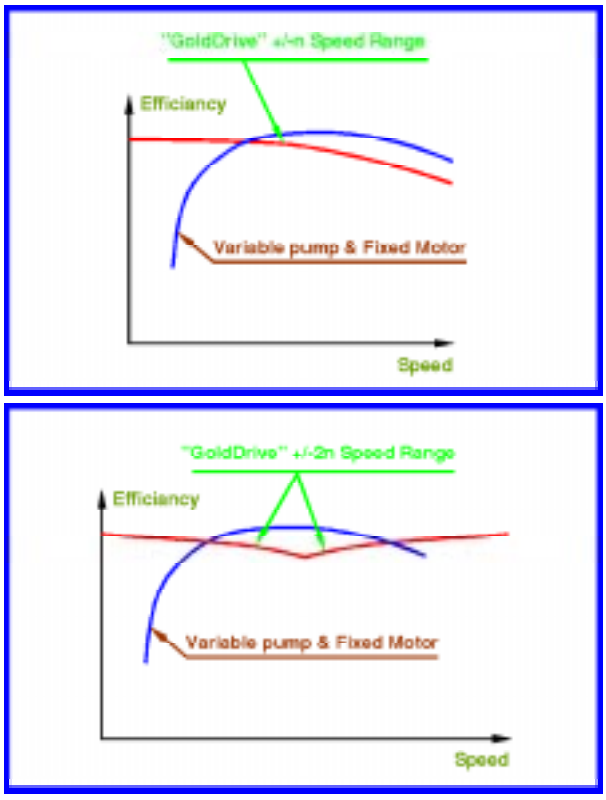

Figure –8 .

9) Conclusions .

9.1) The hydraulic differential , infinite variable , bi-directional drive (HDIVBD) consisting of fixed displacement pumps ……and motors is a promising breakthrough in hydraulic transmissions.

9.2) Based on HDIVBD where we get infinite variable speed at constant flow and fixed displacement units, we conclude ……that we can get infinite variable flow at constant speed and fixed displacement units.

9.3) Differential drives used in mechanical , electrical , hydraulic or pneumatic transmissions are the only possibility to ……get constant starting torque at zero output speed avoiding slippage in traditional transmissions.

10) Complete automotive infinite variable transmission with mechanical differential.

Below , in Figure -10 , an automotive (automatic) infinite variable , bi-directional drive is illustrated .

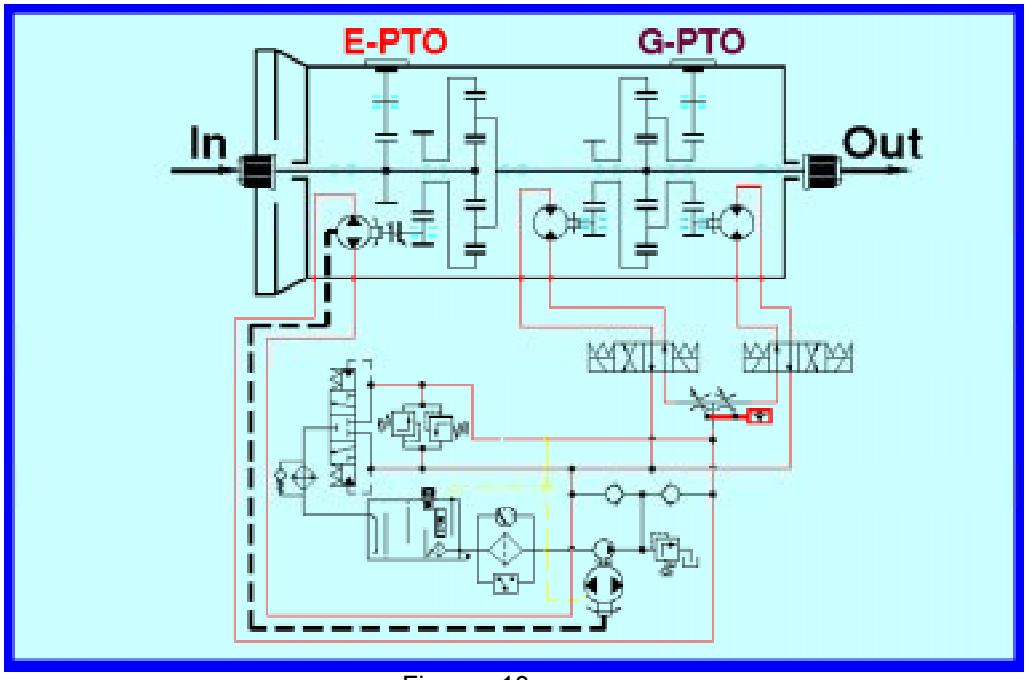

Figure –10 .

11) Complete automotive infinite variable transmission with hydraulic differential “GoldDrive”.

Below , in Figure -11 , an automotive (automatic) infinite variable , bi-directional drive is illustrated.

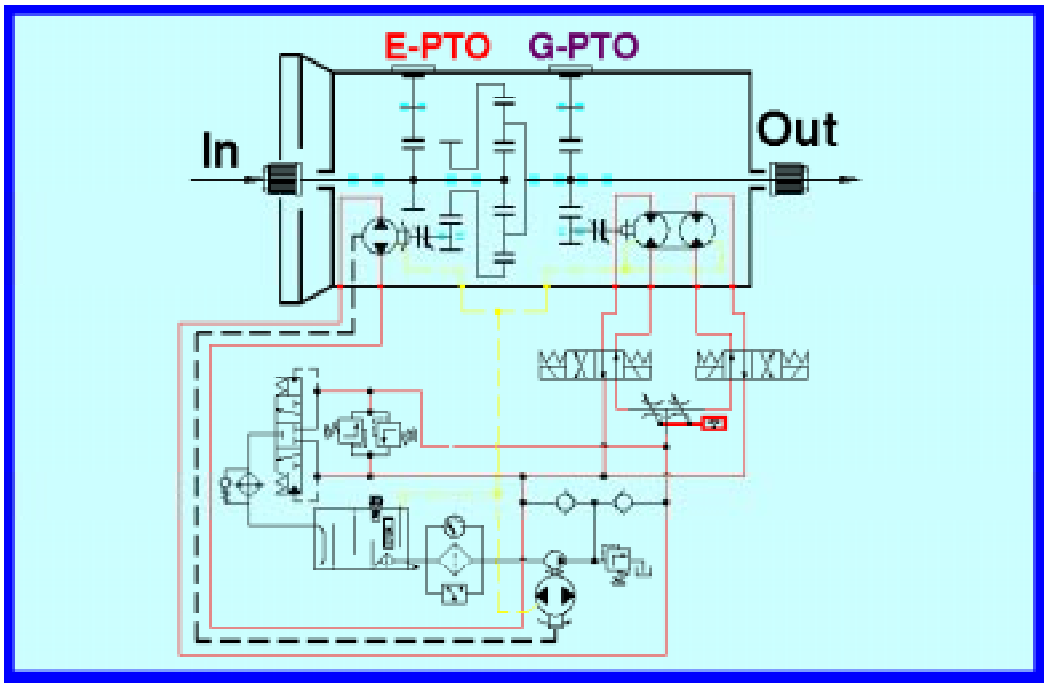

Figure –11 .

12) Basic principle of operation.

Below in Figure –12 , basic principle of operation is illustrated.

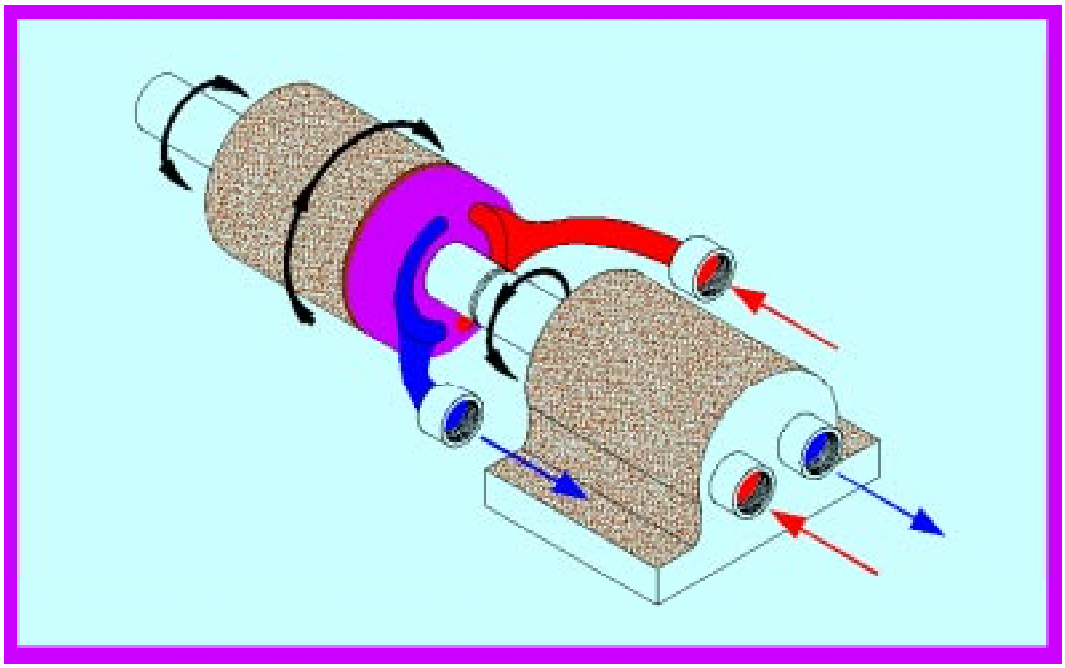

Figure –12 .

13) First prototype , realistic feasibility study.

Below in Figure –13 , first realistic , compact operational transmission , prototype is shown.

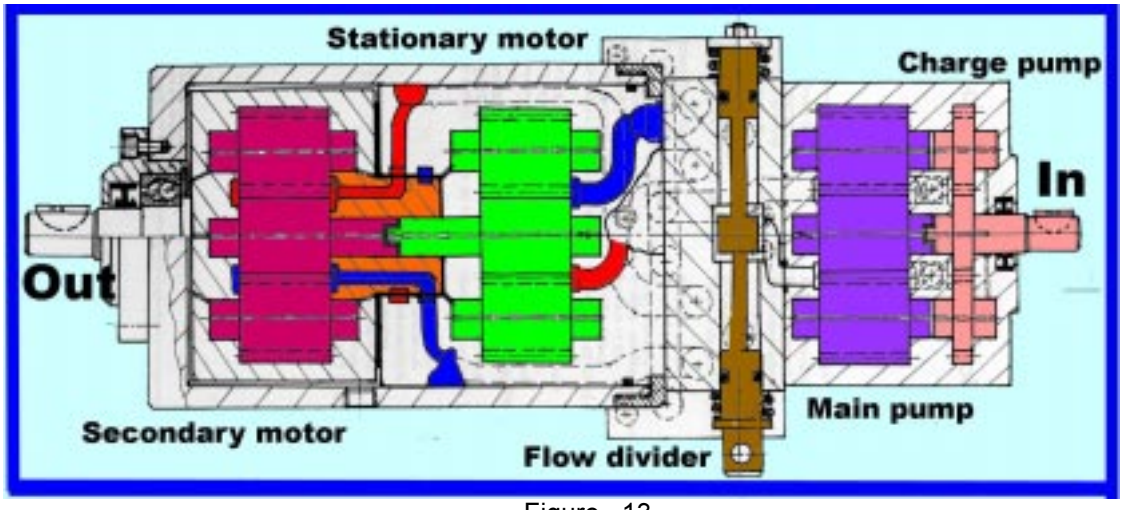

Figure –13 .

14) Second prototype based on “ThreeVar” , three pumping chamber motor .

Below , in Figure –14 , first prototype based on three pumping chamberss , motor.

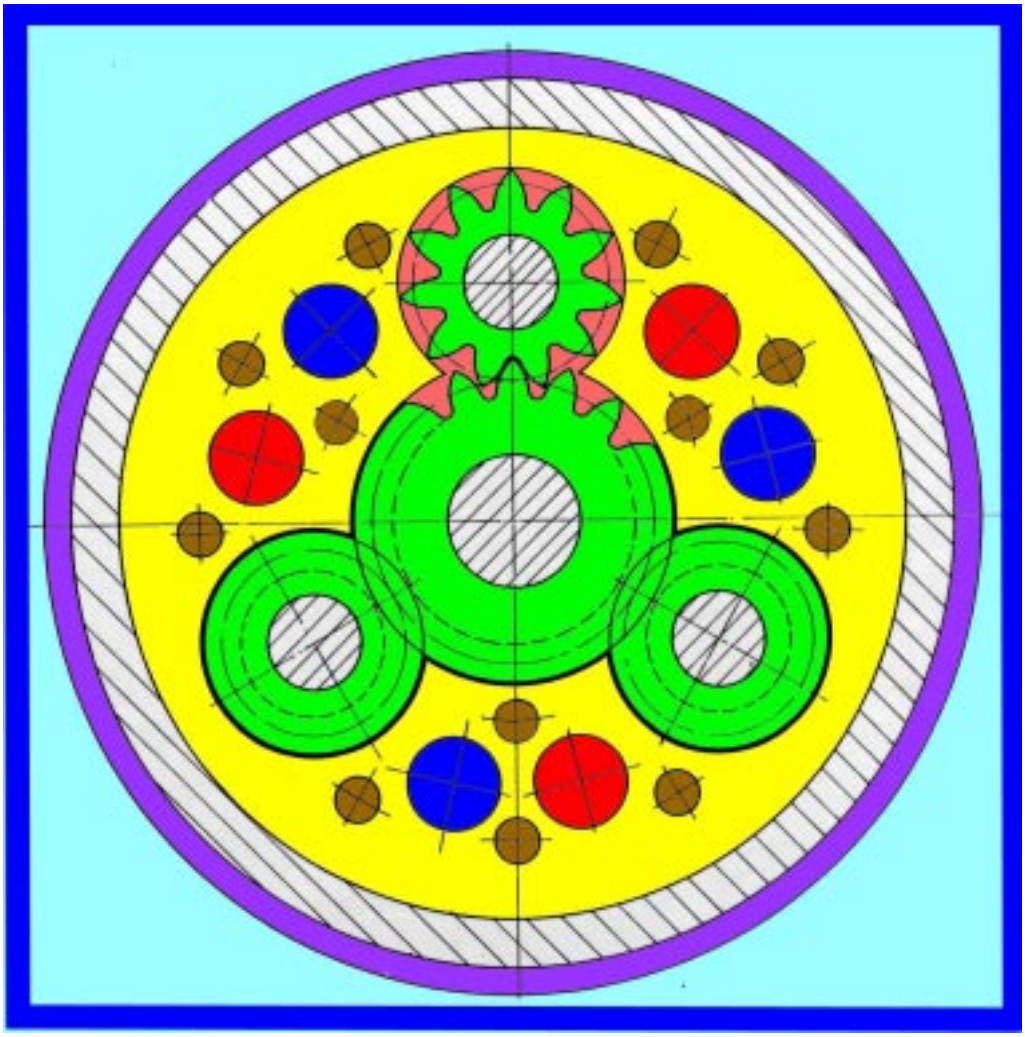

Figure –14 .

This four gear configuration enable to get three times more displacement from nearly the same rotating volume . ……By that we reach three times more torque and power from nearly the same rotating volume . The prototype that . ……was developed , had the following specifications:

1) Corner horse power , **CHP = 200 kW**. 2) Displacement , **q = 250 cc/rev**. 3) Pressure , **p = 21 Mpa** .

4) Speed , **n = 2500 rev/min**. 5) Torque , **T = ~800 N$_x$m** 6) **Specific power = 1,1 kW/Kg**.

15. The final “GoldDrive” , based on “ThreeVar” , three pumping chambers - motor .

On Figure 15 , a cutway view of the final first prototype is shown. This is the motor only without fixed displacement ……pump , charge pump and valves.

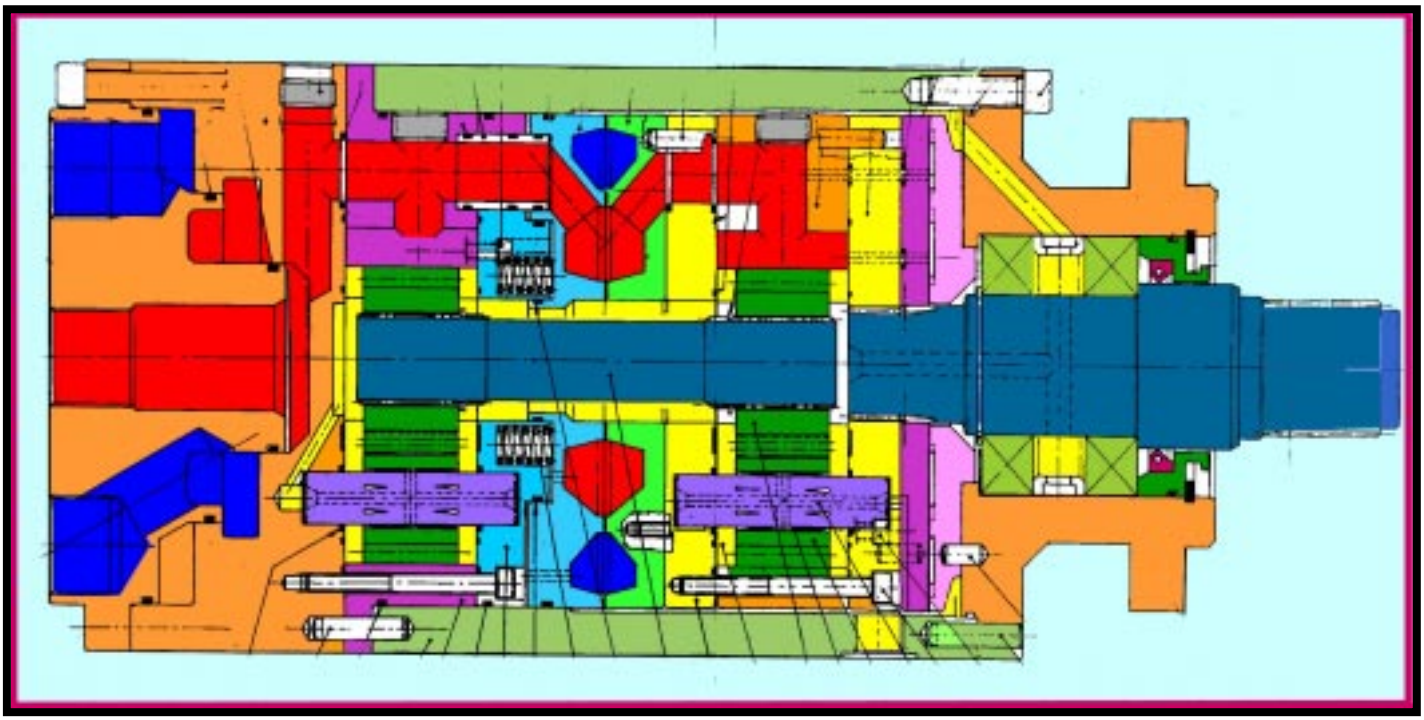

Figure –15 .

16. Contact .

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