Oct. 3, 1967 R. H. WILSON 3,344,715

HYDRAULIC MOTORS

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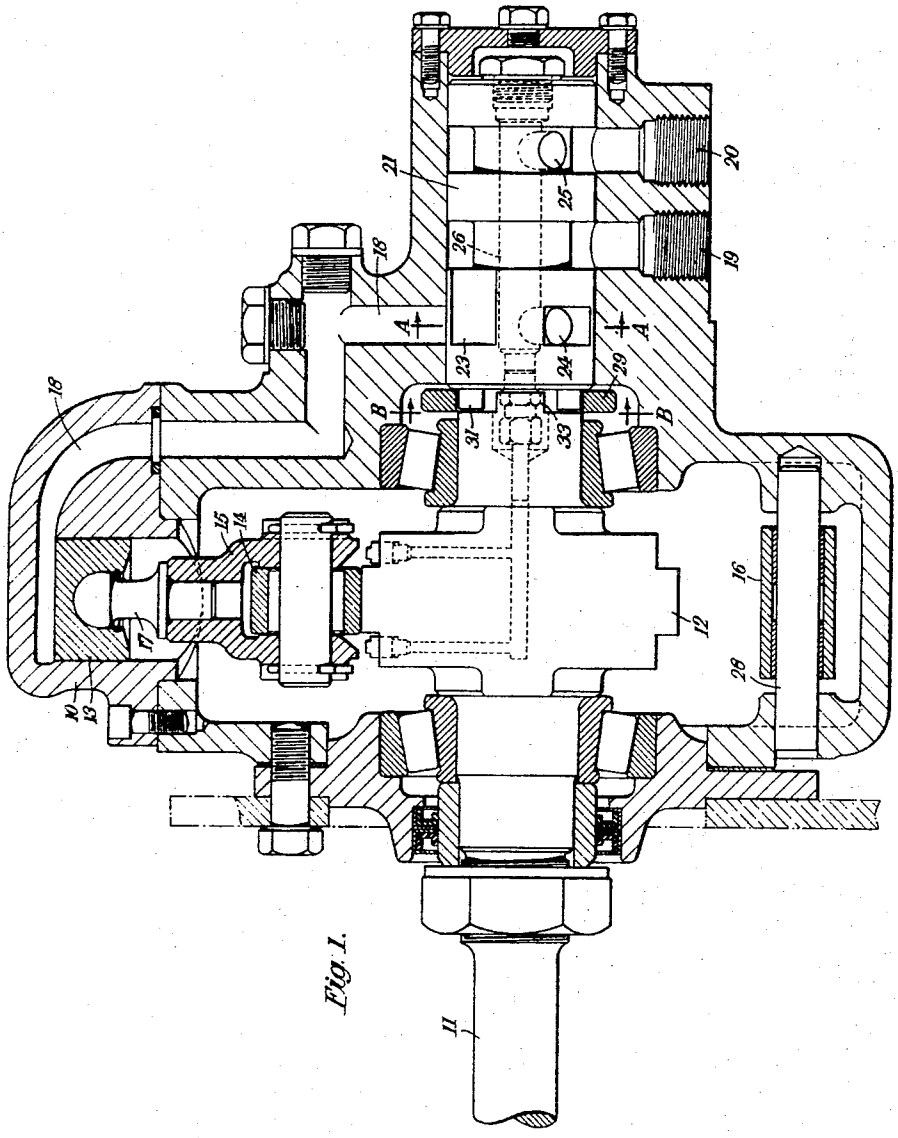


Fig. 1.

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HYDRAULIC MOTORS

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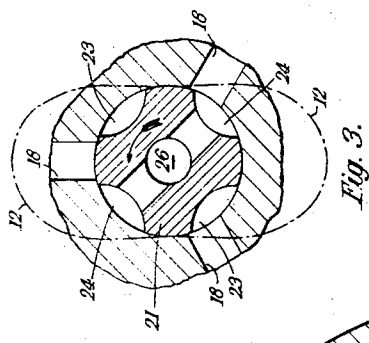


Fig. 3.

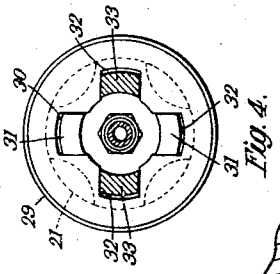


Fig. 4.

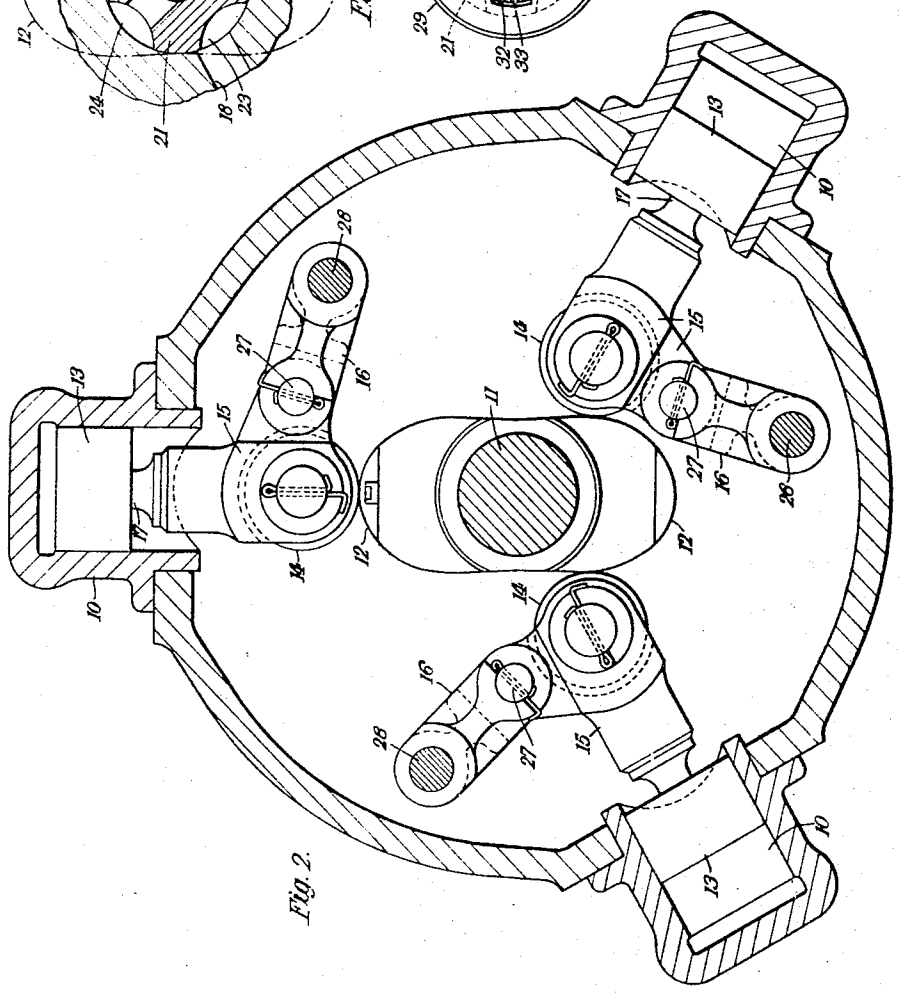


Fig. 2.

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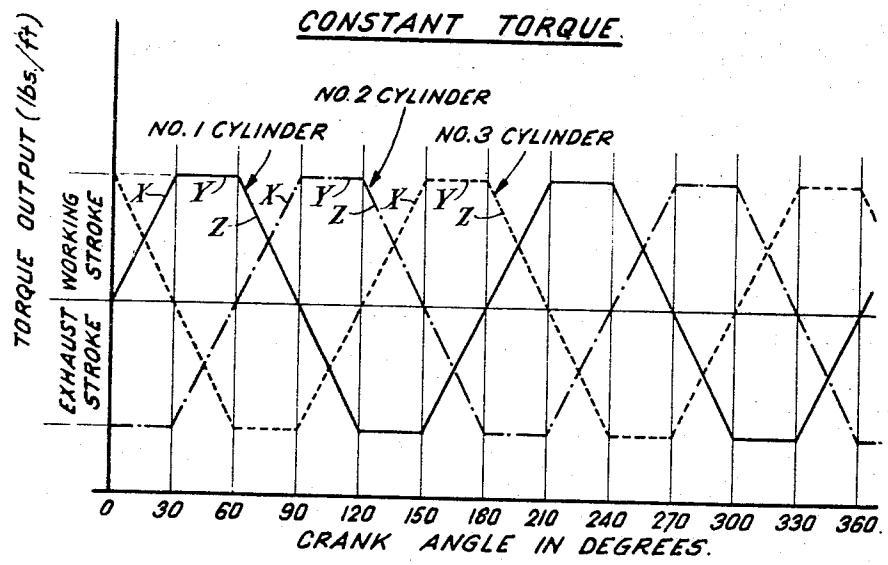


Fig. 5A.

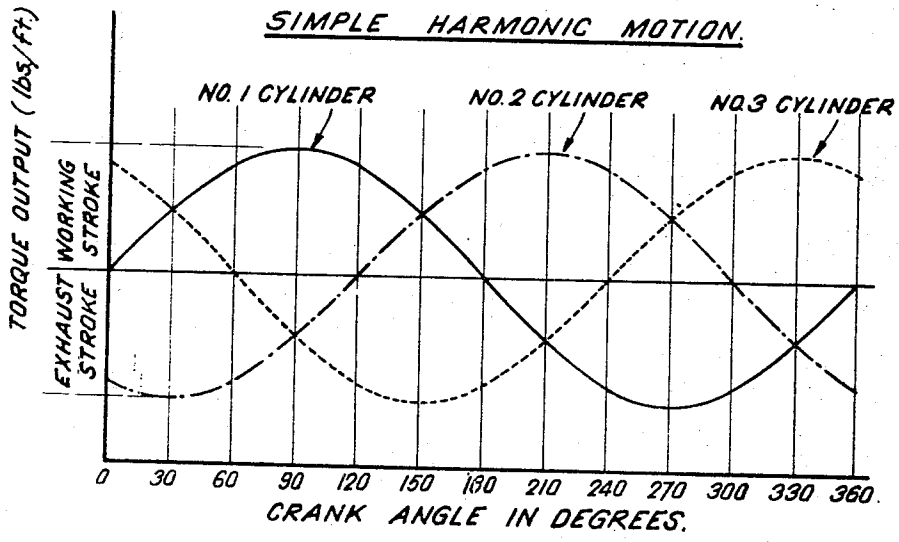


Fig. 5B.

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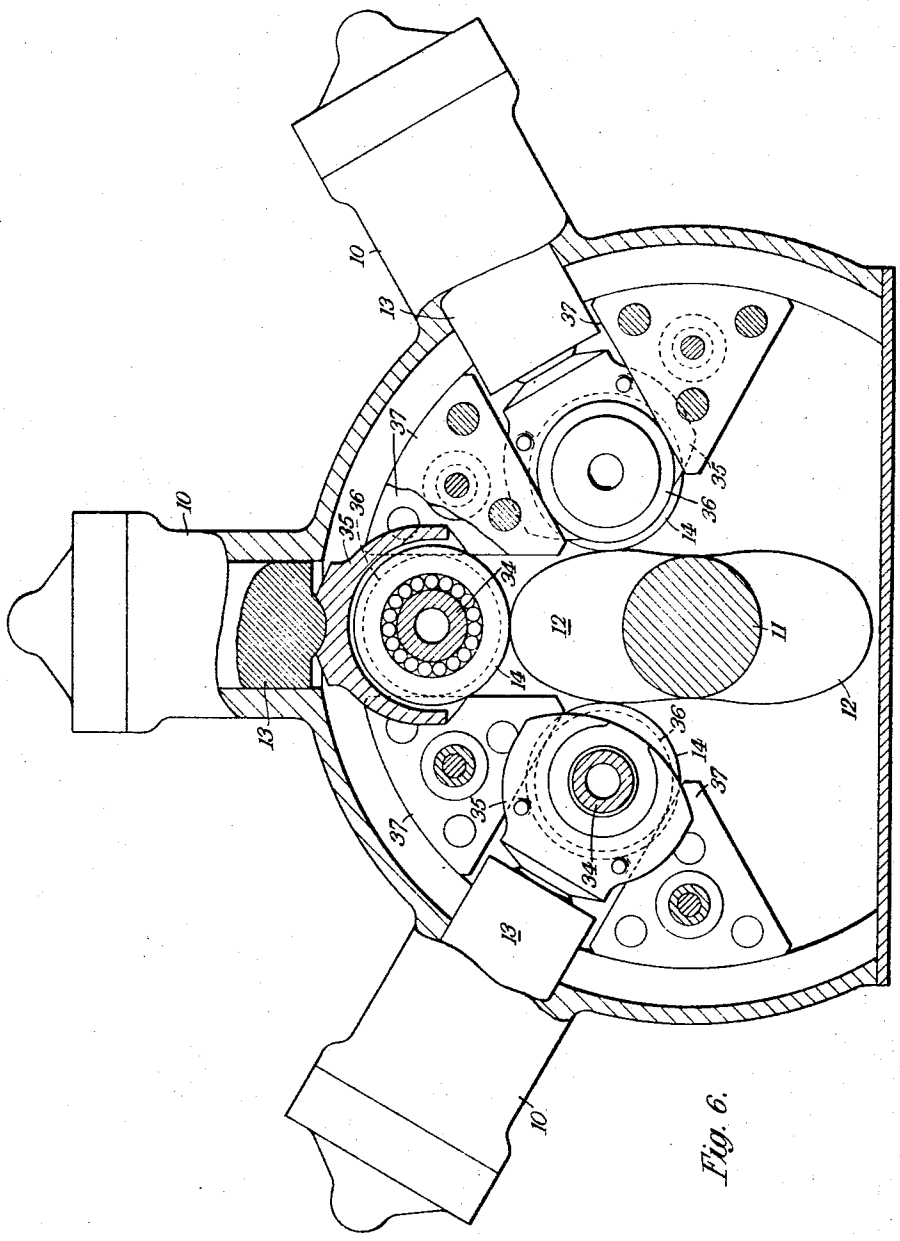


Fig. 6.

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HYDRAULIC MOTORS

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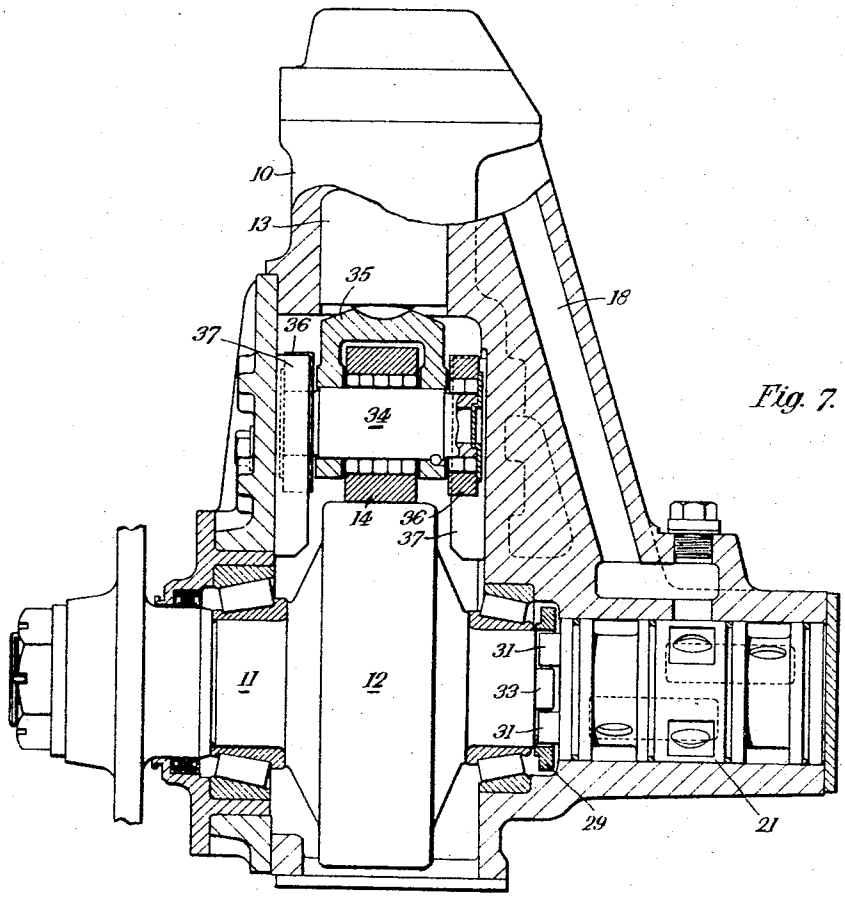


Fig. 7.

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United States Patent Office 3,344,715 Patented Oct. 3, 1967

3,344,715

HYDRAULIC MOTORS

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Filed July 27, 1964, Ser. No. 385,295
1 Claim. (Cl. 91—180)

This invention relates to hydraulic motors of the radial type, i.e., the type comprising an odd number of radially disposed cylinders, a rotary valve which connects the cylinders in succession to pressure and exhaust and a central output shaft carrying a two lobe cam which is driven by the pistons in the cylinders.

The cam in existing motors of this type is normally a harmonic cam, in which case the acceleration of the pistons decreases from a maximum at top dead center to zero when the cam has rotated through 45° from the top dead center position, and deceleration of the pistons increases in similar fashion from this position to bottom dead center. With such a cam, the output shaft is subject to torque fluctuations notwithstanding the fact that the motor is supplied with a constant flow of motive liquid and it has hitherto been necessary to provide the motor with at least five cylinders in order to obtain adequate smoothing of the torque fluctuations.

The invention provides a hydraulic motor of the above type which has three cylinders only and in which the cam is so shaped that the output shaft is driven at substantially constant torque. This can be achieved when the profile of the cam is such that the pistons move at constant acceleration over the first 30° of rotation of the cam from top dead center (which corresponds to a quarter of the piston stroke), then move at constant velocity over the next 30° of rotation of the cam (which corresponds to the following half of the piston stroke) and then move at constant deceleration over the next 30° of rotation of the cam.

Two embodiments of hydraulic motor according to the invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal section through the first form of motor,

FIG. 2 is a corresponding cross section,

FIG. 3 is a section on the line A—A in FIG. 1,

FIG. 4 is a section on the line B—B in FIG. 1,

FIGS. 5A and 5B are diagrams showing respectively the torque imparted to the output shaft in a motor having a cam shaped in accordance with the invention and in a motor with a conventional harmonic cam,

FIG. 6 is a cross section through an alternative form of motor, and

FIG. 7 is a corresponding longitudinal section.

Like reference numerals designate like parts throughout the figures.

The motor shown in FIGS. 1–4 has three equally spaced cylinders **10** surrounding the output shaft **11** which carries the two lobe cam **12**. The piston **13** in each cylinder bears against the cam **12** through the agency of a roller **14**, mounted in a rocker **15** pivoted at **27** to an arm **16** which can turn about a pivot **28**. The rocker **15** carries a spigot **17** which is received in a recess in the piston. A duct **18** leads to the outer end of each cylinder and is connected alternately to a pressure inlet **19** and an exhaust outlet **20** by a pintle valve **21** which is connected to the shaft **11** by a coupling. As shown in FIG. 4, the coupling consists of a plate **29**, having a pair of recesses **30** engaged by dogs **31** on the valve **21** and another pair of recesses **32** engaged by dogs **33** on the shaft **11**. This coupling permits of some degree of floating of the pintle valve **21** as it is rotated by the output

shaft **11**. The valve **21** has a pair of inlet ports **23** (FIG. 3) which periodically connect the ducts **18** to the inlet **19** and two pairs of exhaust ports **24**, **25**, cooperating respectively with the ducts **18** and with the outlet **20**, which are connected by a central duct **26** in the valve.

The advantages of the motor according to the invention over a motor with a harmonic cam will be apparent from a comparison of FIGS. 5A and 5B which show torque plotted against crank angle, i.e., angular position of the output shaft **11**. As will be seen from FIG. 5B, the torque fluctuations are substantial and can only be smoothed out to an acceptable value by providing the motor with at least five cylinders. In the case, however, of the motor according to the invention and shown in FIG. 5A, each piston moves at constant acceleration over the first 30° rotation of the cam from top dead center, as indicated by the lines X, then move at constant velocity over the next 30° rotation of the cam, as indicated by the lines Y, and then move at constant deceleration over the next 30° rotation of the cam, as indicated by the lines Z. Accordingly the output shaft is driven at constant torque.

It is possible to move any of the three cylinders **10** from the position shown in FIG. 1 to a diametrically opposite position and this makes it possible to arrange all the cylinders above the shaft **11**, as shown in FIGS. 6 and 7. Motors of the type in question may be fitted to the driven wheels of a vehicle provided with a hydraulic transmission and this arrangement of the cylinders is convenient where ground clearance is required to be low, as for example in the case of locomotives or crawler tractors. Apart from the different disposition of the cylinders, the motor shown in FIGS. 6 and 7 differs only from that shown in FIGS. 1–4 in that different means are provided for guiding the rollers **14** which coact with the cam **12**.

Each roller **14** is mounted on a spindle **34** carried by a frame **35** which abuts against the piston **13**. The spindle **34** carries at its ends guide rollers **36** which run on guides **37** on the housing of the motor.

The motor according to the invention can be used for industrial applications, e.g., for operating lifts or lock gates and it may in some circumstances find useful application as a hydraulic pump.

What I claim as my invention and desire to secure by Letters Patent is:

A hydraulic motor comprising a plurality of radially-disposed cylinders respectively having pistons reciprocable therein in response to fluid pressure in the cylinders, a rotary valve driven by said motor for connecting the cylinders in succession to fluid under pressure and to exhaust, a central output shaft and a cam affixed to said shaft for rotation therewith, said cam having only two relatively diametrically-opposed lobes, and follower means carried by the respective pistons for operative engagement with said lobes to rotate said cam, said motor having only three cylinders angularly spaced from each other, the lobes of said cam respectively occupying diametrically-opposed halves of the cam profile, the said profile being shaped to produce a constant acceleration and deceleration of the piston movement throughout the first and last quarters respective of the power stroke of each piston, and to maintain a constant piston velocity throughout the second and third quarters of the power stroke of each piston, when the cam is driven at a constant angular velocity, the pistons and cam being arrange relatively to each other so that the first 30 degrees of cam rotation from a rotational position in which the crest of one of said cam lobes is engaged by a said follower means corresponds to the first quarter of the power stroke of the piston, the second 30 degrees of rotation of said cam corresponds with the second and third quarters of the power stroke of the piston, and the third 30 degrees

of rotation of the cam corresponds to the remaining quarter of the piston power stroke, to thereby generate three separate output curves corresponding to said three cylinders, each of said curves having angular intersections between said first and second quarters of said power stroke and between said third and fourth quarters of said power stroke, whereby to provide a substantially smooth summation output curve of said motor.

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