PUBLISHED
JUNE 15, 1943.
BY A. P. C.

B. BRANDA
ASSEMBLY OF DEVICES PERMITTING A RATIONAL TRANSMISSION OF MECHANICAL POWER, PARTICULARLY FITTED FOR MOTOR-CARS
Filed Jan. 8, 1941

Serial No. 373,705
7 Sheets—Sheet 1

Fig. 1.

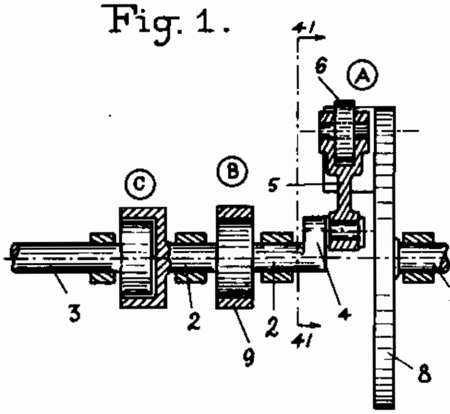


Fig. 2.

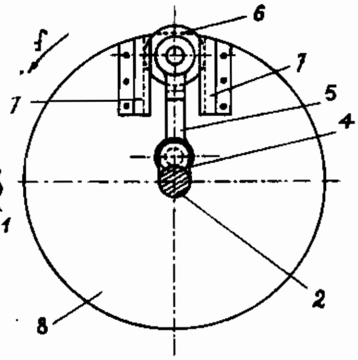


Fig. 3.

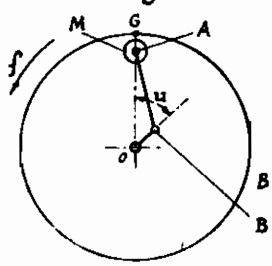


Fig. 4.

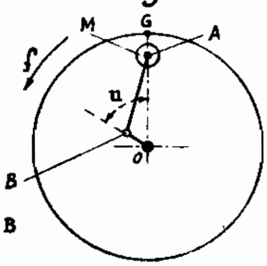


Fig. 5.

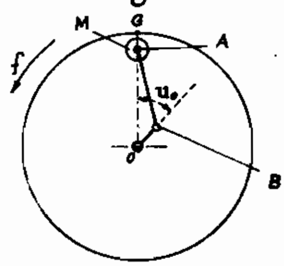
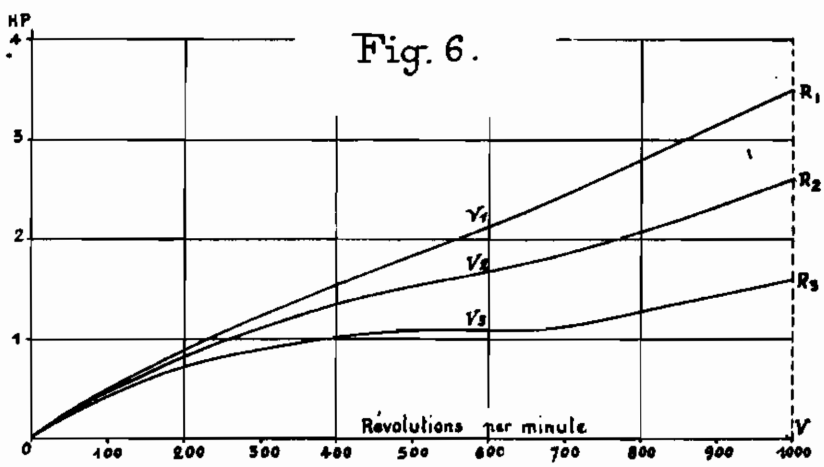


Fig. 6.



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7 Sheets-Sheet 2

Fig. 7.

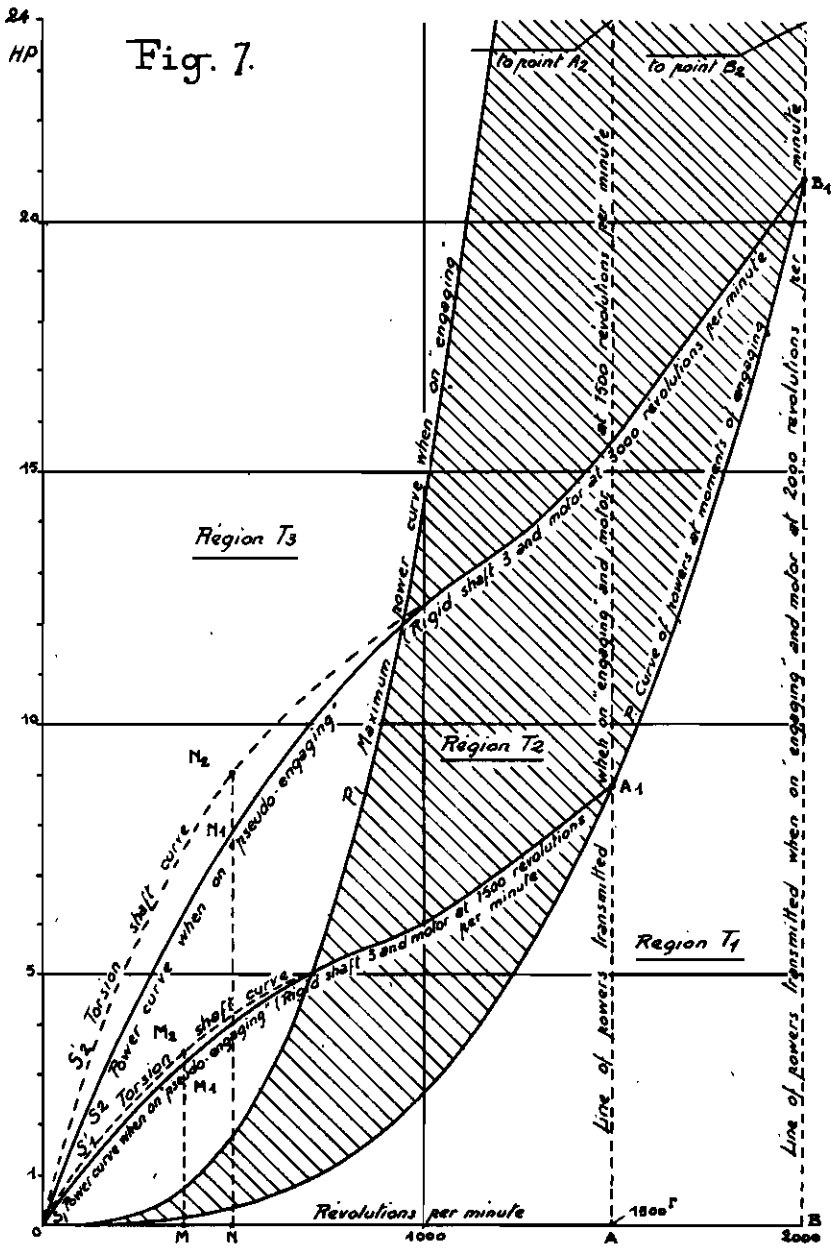

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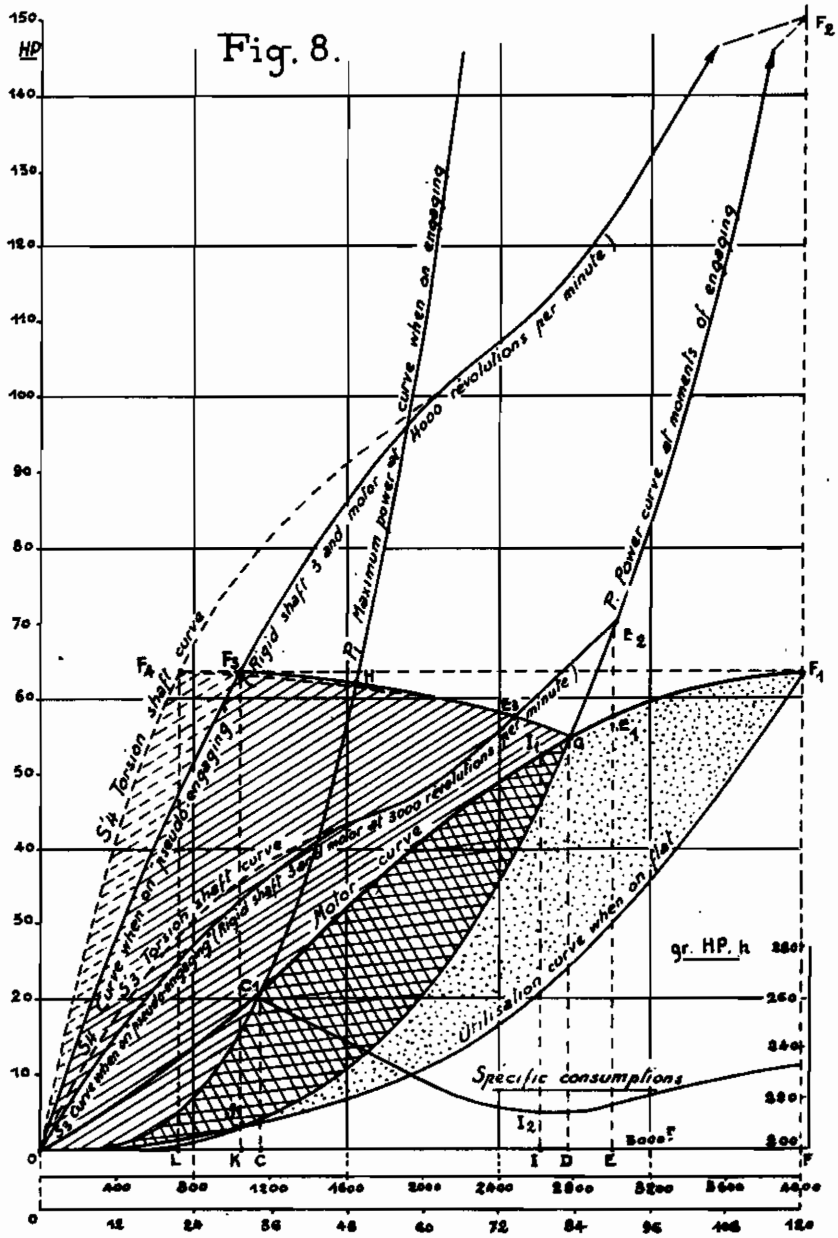
Fig. 8.



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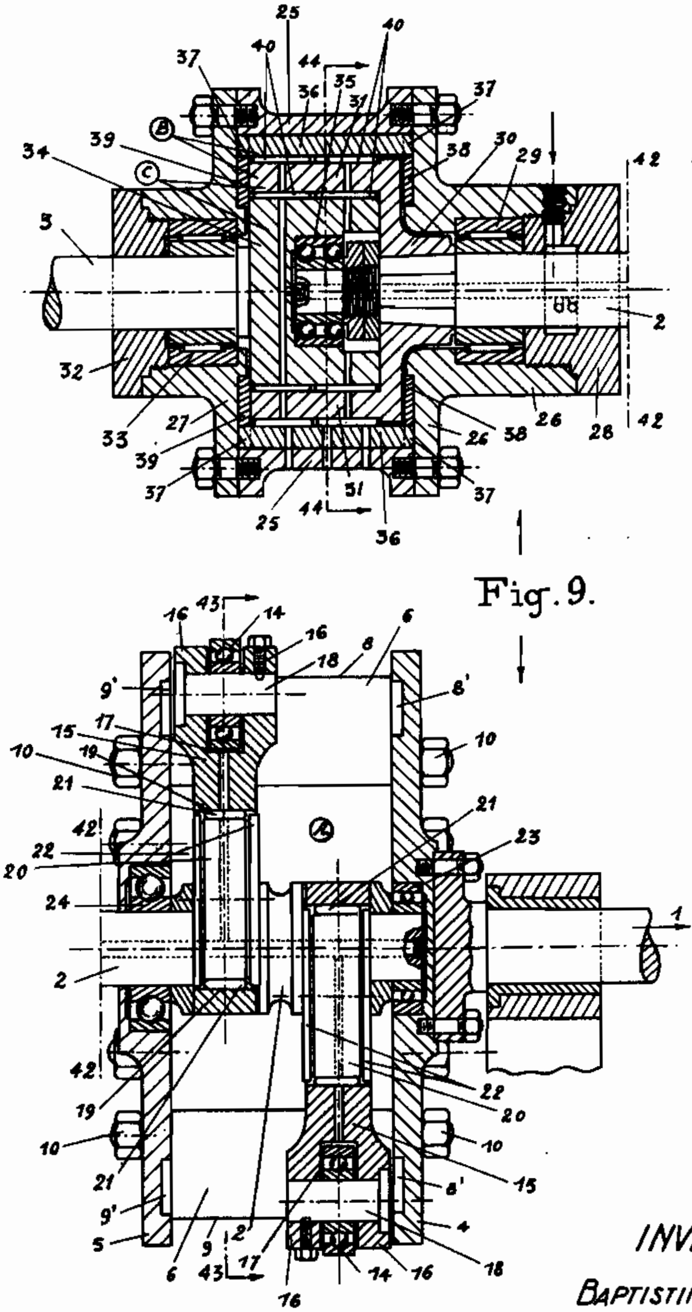

Fig. 9.

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Fig. 10.

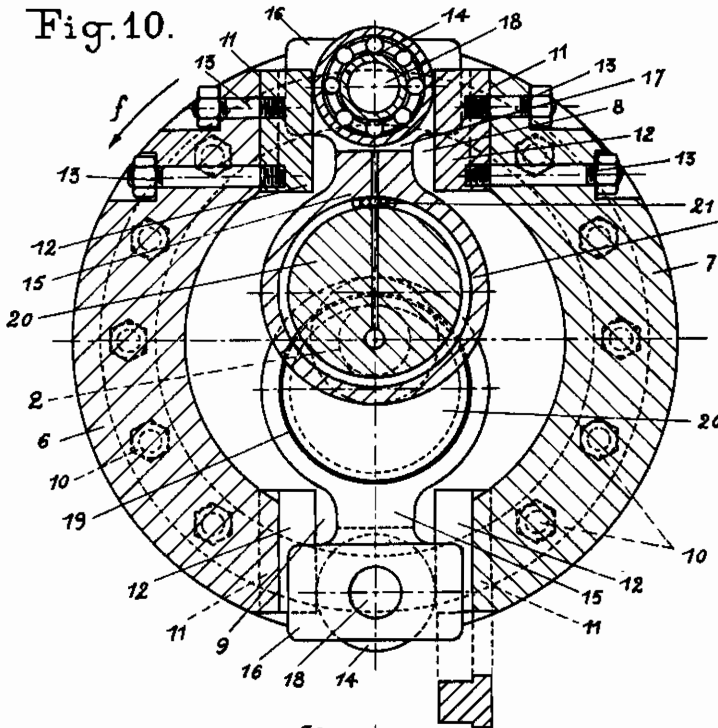


Fig. 11.

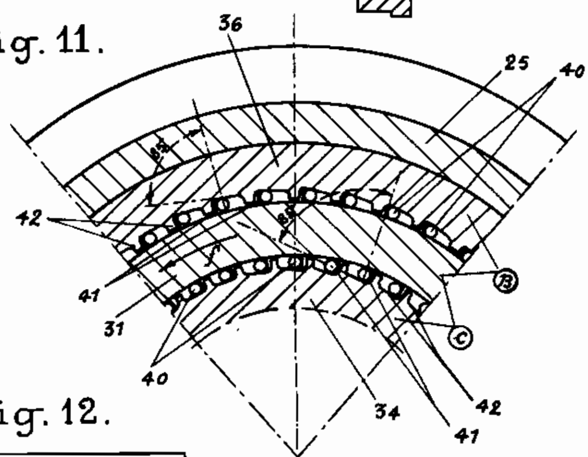
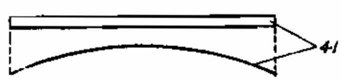


Fig. 12.



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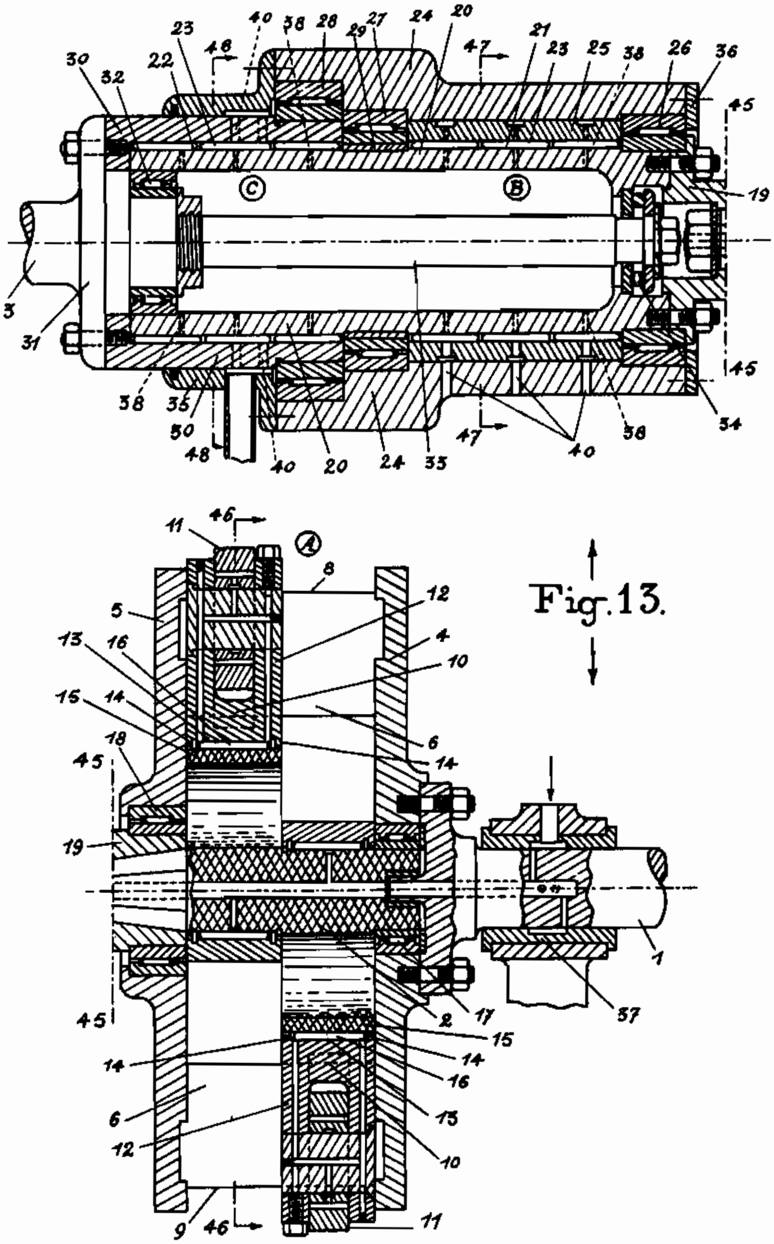

Fig. 13.

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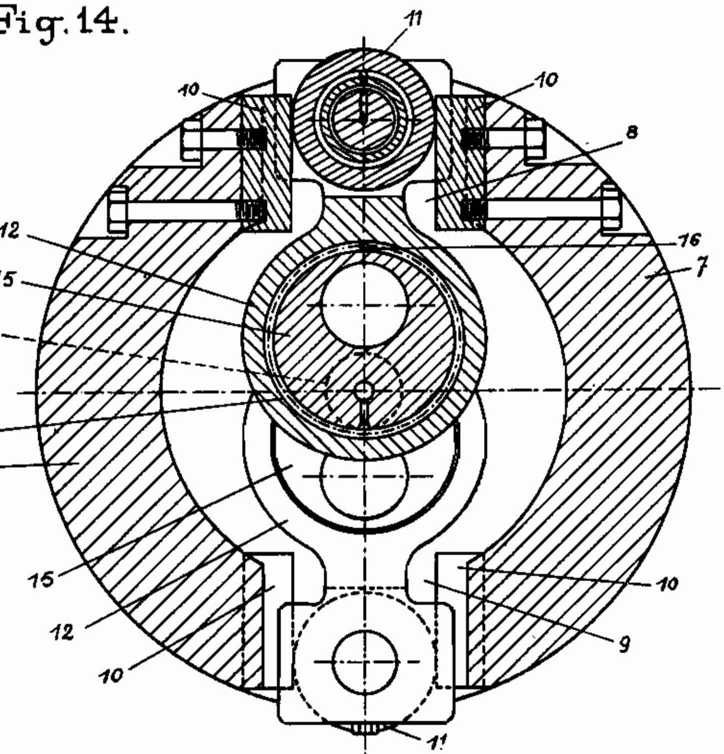
Fig. 14.



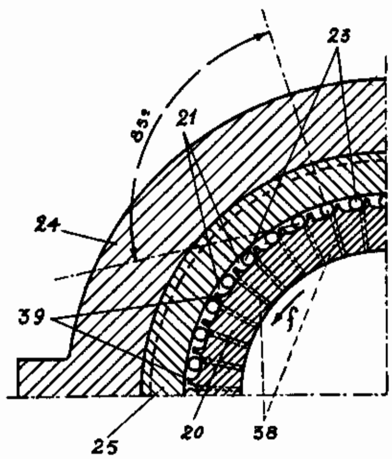


Fig. 15.

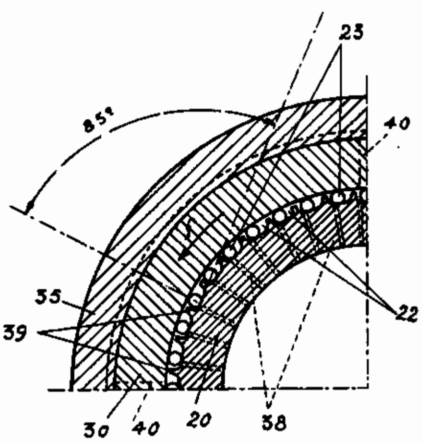


Fig. 16.

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Published June 15, 1943 **Serial No. 373,705**

ALIEN PROPERTY CUSTODIAN

ASSEMBLY OF DEVICES PERMITTING A RATIONAL TRANSMISSION OF MECHANICAL POWER, PARTICULARLY FITTED FOR MOTOR-CARS

Baptistin Branda, Marseille, France; vested in the Alien Property Custodian

Application filed January 8, 1941

The object of the present invention has been the realisation of an assembly of devices destined to substitute, on the one hand, the change gear box, and on the other hand, the clutch on motor-cars; and generally, all similar adjustments mounted on other machines using power at a variable speed.

This assembly fulfills the following conditions:

1°—Realisation of necessities for a rational transmission of power by only actuating the gas admission valve thus permitting:

(*a*) Powerful startings or strong accelerations by the eventual production at the given time and to the maximum of the mean couple, without any risk of stopping the motor.

(*b*) The possibility to maintain the gears on direct drive within very large limits.

(*c*) The realisation of a regimen on an automatic high gear ratio with a very great variety of speeds, permitting thus a constant equilibrium between the power furnished by the motor and the useful work realised. This regimen, possesses a certain value below the corresponding lower speed of the car, being self established, or obtained at will by modifying quickly enough the speed of the engine within the proper limits, which will be specified later, and which will fulfill all the various needs.

(*d*) The possibility for the driver, when the regimen on an automatic high gear ratio is established, to accelerate more or less the motor, without any risk of getting an excessive acceleration, as the thing may possibly occur actually if the gear ratio chosen is a bad one. During this regimen and when the motor gives its whole efficiency, the speed of this latter changes but within limits which are practically very small, determined at the building, and this whatever the degrees of rising of the upward slope on which riding. These extreme limits are determined by the various speeds giving, when fully loaded, on the one hand, the minimum of consumption of fuel by H. P. hour, and on the other hand, the maximum of efficiency of the motor.

(*e*) The automatic re-establishing of the direct drive as soon as this latter becomes possible.

2°—Appreciable economy of fuel when on high gear ratio regimen.

3°—Mechanical efficiency, reliability, weight, volume and price of construction of the new assembly for the least comparable to the same elements of the actual solutions.

4°—Suppression of the clutch, when this latter is actually indispensable for the various changing of speed or to get the motor running while the vehicle is stopped.

In order to facilitate the reading of the following exposition, the drawings hereunto annexed, are given to show, on one hand, the principles of the arrangements constituting the basis of the invention, and on the other hand, to illustrate two industrial realisations.

Figures 1 and 2 show respectively: the one a longitudinal section, and the other a cross section through **41—41** of Figure 1, of a diagrammatic assembly enabling one to see more clearly the principles of the devices.

Figure 3, 4 and 5 are diagrammatic schemes of the dynamic connections so as to better understand the following exposition.

In Figures 6, 7 and 8 are graphs showing the possibilities of the devices comprised in the assembly.

Figures 9, 10, 11 and 12 represent successively: the two parts of a longitudinal section, splitted through **42—42**, of the first industrial realisation; two cross sections through **43—43** and **44—44** of Figure 9, the second one being drawn on a greater scale; and a double view of the plate springs used in this case.

Figures 13, 14, 15 and 16 represent respectively: the two parts of a longitudinal section, splitted through MM, of a second industrial realisation; and three cross sections through **46—46**, **47—47** and **48—48** of Figure 13, the two last ones being partially drawn and on a greater scale.

These two examples of industrial realisations are given without any limitation in the shapes, neither in arrangements of parts, nor in dimensions and nature of the metal used.

Principles of the devices of assembly (plates 1—2—3)

Three independent shafts **1**, **2**, and **3** (Figures 1 and 2) are placed on the same axis. The driving shaft **1** turns in the direction of the arrow *f*; shaft **2** which constitutes an intermediate one; and shaft **3** is connected with the apparatus using the power of the engine.

Shafts **1** and **2** are linked by the dynamic connecting device A which permits all angular movements of these shafts but gives to shaft **2** rotary couples which will be examined further.

Shaft **2** is provided with the device B constituted by a stationary collar bracket **9**, judiciously established so as to permit rotating of this shaft only in the direction shown by the arrow *f*.

Shafts **2** and **3** are connected by the driving device C which allows shaft **2** to transmit a rotation of the shaft **3** in the unic direction of the arrow *f*, but only in the case where the speed of shaft **2** tends to become higher than that of shaft **3**. On the other hand, would the speed of shaft **2** become lower than that of shaft **3**, then this latter being left independent would continue its proper motion carried on only by the inertia of the using apparatus.

Device A, in principle, is constituted of a crank **4** integral with shaft **2**; on the pin of the crank **4** is fitted the eye of the connecting rod having on the other end a fork. The forked end of the connecting rod 5 is adjusted with the roller 6 that moves freely along radial slide plates 7 secured on the circular plate 8 integral with shaft 1.

This device as shown, being provided with a single connecting rod and crank system, would completely be out of equilibrium: it would be necessary to have at least two symmetrical systems with their cranks at 180°. But for the sake of simplification of the description and having in sight that the conclusions must be the same whether we consider a single system or a compound one, we will continue our description of the device as above sketched.

On the other hand, the devices B and C to which we give the name of "mechanical filters" are using the principles known on the no-reversing and more particularly the improvements which are the object of the distinct patent taken by the same inventor bearing the title of: "Driving Device in One Direction Only, for Important Couples, with Rapid Frequencies of Action at High Speed".

The dynamic connection A produces a centrifugal force which acts on the whole mass M at the connecting rod bottom end A (figure 3), thus participating to the driving rotation in the direction of arrow f, so that the distances from the axis 0 depend on the angle formed by shaft 1 turning respectively to shaft 2. In such a system there is independence between the two shafts, as it may be seen in the strict cinetic point of view, but their dynamic reactions take place under the centrifugal effect that tends to get away the mass M from the axis and consequently to decrease the angle GOB.

When the slide OG turns at the uniform angular velocity ω, one has to verify that the couple acting upon shaft 2, consequently at the centrifugal effect, has sensibly the value

$$\Gamma=\frac{K}{2}\omega^2 \sin u \qquad (1)$$

in which formula u represents the angle BOG. This couple is either a working or a resisting one according to the positions of the crank and slide as shown in figures 3 and 4 respectively, that is to say, nearly a half revolution, when OB is retarded or in advance from OG.

Verification of the value K has to give:

$$K=2M\times L\times R \qquad (2)$$

(L and R representing the length of connecting rod and crank respectively), when the ratio

$$\frac{R}{L}$$

is supposed low.

The ratio of the relative shifting of shafts 2 and 1 is defined by the parameter u and, from that we have previously seen, it must be intuitively understood that for the value $u=0$ we shall have a relative stable equilibrium, in the case where shaft 2 is not subjected to any resistent couple Of course, when shaft 2 which momentaneously acts as a driven one, is subjected to the resistent couple ψ, yet, a relative equilibrium remains possible on the condition that ψ does not go beyond the maximum value

$$\frac{K}{2}\omega^2$$

of the couple Γ. The corresponding value of the parameter u is defined thus:

$$\sin u_0=\frac{2\psi}{K\omega^2} \qquad (3)$$

and the equilibrium will be stable so as if u_0 is taken for the acute angle fulfilling this condition (figure 5).

It is clear that it will be possible to observe oscillatory motions of u about the value of stable equilibrium $u=0$ (when ψ is naught or $u=u_0$ (when ψ is aught). These oscillatory motions are corresponding to the regimens of movements, which we shall name "engagings" (driving couples), of shafts 1 and 2: shaft 2 accompanying shaft 1 in its rotation with an angular velocity oscillating around the mean value ω. It may be said, too, that there is "direct drive".

In order to have a driving couple (engaging) it is evidently necessary that the position of relative equilibrium u_0 exists. It is then absolutely indispensable that the resisting couple is sufficiently feable so as to fulfill the condition

$$\psi<\frac{K\omega^2}{2} \qquad (4)$$

but the limit of this value increases as the square of the angular velocity of the driving force.

We may consider, on the other hand, the possibility to get an "engaging" (driving couple) even starting from the state of rest of shaft 2. A mathematical study in this case brings us to the following conditions:

$$\frac{C}{K}<2 \qquad (5)$$

C being the momentum of inertia of shaft 2; this latter condition being only necessary as above said for the condition (4). It is possible for us, then, to say that C/K is the index T of the devices.

When an "engaging" (driving couple) does not occur, the angle u arrives at variations always in the same direction, the dynamic device connection becoming thus inefficient: the couple Γ which acts upon shaft 2 producing effects which are alternatively driver and driven, and shaft 2 being carried in the same direction of couple ψ keeps its mean movement without any alteration from the dynamic connection.

It is possible then to arrive at the conclusion that if the dynamic connection A puts in evidence the fundamental phenomenon of the "engaging" (driving couple), it is clear also that it has to be completed in order to be capable of being used for the transmission of power at variable speeds. This brings us to an exact explanation of the object of filters B and C.

The object of first filter B is to correct the insufficient dynamic connection when there is no "engaging" (no-driving couple). It produces the necessary actions so as to permit no movement of shaft 2 in the direction of the resisting couple, which direction we shall call negative, whereas it does permit these movements in the positive direction. Calculations put in evidence the following properties of the system completed by this first filter.

Now, let us consider only the case where shaft 2 is initially at rest:

1°—It will indefinitely remain at rest if we have:

$$\psi>\frac{K}{2}\omega^2$$

$$\frac{K}{2}\omega^2$$

being therefore the starting couple.

2°—If, on the contrary, we have:

$$\psi<\frac{K}{2}\omega^2$$

shaft 2 starts running in the positive direction. At the moment where u equals the value u_0 previously determined (Formula 3), then two cases are possible:

(a) For values lower than ψ and, at the condition (5) already mentioned that the index is less than 2, there is "engaging" (driving couple).

(b) For values higher than ψ, the turning of shaft 2 firstly accelerated, becomes then slow and finally stops, to start again when according to the relative shifting of shaft 1, the angle u takes again the value u_0. Thus we shall have a series of movements of shaft 2, identical to themselves but separated by intervals of rest. This is the regimen, to which we shall give the name of "disengaging couple."

This regimen, or rather the series of them are effectively well a transmission of power performed at variable speed of shaft 2. Nevertheless, all this is not sufficient so as the apparatus, though completed by the first filter B, be satisfactory.

The data of construction and the value of the resistent couple ψ determine the regimen, which will be established at the starting and will remain during the whole course of the movement, either a regimen of "disengaging" or an "engaging" one (driving). It is easy to note that in the driving case, starting from the state of rest of shaft 2, the angular velocity of this shaft varies periodically from 0 to 2ω, which is a quantity of variation too much greater.

The inconvenient that we have just now indicated is essentially theoretical, for we can rely on certain effects of inertia and elasticity in order to get practically an uniform angular velocity of shaft 2, but, other objections remain to be eliminated yet.

Shaft 2 working, as supposed until now, as a driven one, it is necessary to understand in its momentum of inertia C, the inertias of the using apparatus which must be actuated. It becomes then impossible to practically fulfill the condition

$$\frac{C}{K}<2$$

condition however necessary so as to get the driving couple (engaging): the ratio

$$\frac{C}{K}$$

becoming thus, generally, not only greater than 2, but even very much greater. Every regimen of "engaging" (driving coupling) will then be impossible, and it becomes easy to note that, when on regimen of "disengaging" the angular velocity of shaft 2 will be unable to go beyond the angular velocity of working power but only for a small fraction.

These difficulties are overcome by the application of the cinetic connection, not directly to driven shaft, but by means of an intermediate one of which the inertia can be easily chosen so as to have an index

$$\frac{C}{K}$$

smaller than 2. It becomes then necessary to provide a suitable connection between the intermediate shaft (shaft 2) and the new driven one (shaft 3).

The second filter C fulfills this condition: it is sufficient, so as to explain its action, to say that it carries the two shafts 2 and 3 together every time that, when the movements of these shafts are free, we have:

Angular velocity of 3—angular velocity of 2<0, it does not bring on the contrary any obstacle to the movements for which the previous difference is positive.

It is by means of this second filter, generally completed by the shaft of torsion 3, of which one of the principal advantages consists in the smoothing of working of the various organs, that transmission of power can be satisfactorily assured.

The mathematical study of the complete apparatus is a little more delicate than that applied to the cases previously examined. The value of the starting couple does not change, but in the discussion of the movement, we have to take in account two indexes: the one T′ of the whole which acts at the moments where filter (C) secures together the two shafts 2 and 3, the other T peculiar to shaft 2 and acting when filter (C) makes free shaft 3. This latter index is lower than 2, whereas the former T′ will be in the practical cases from 100 to 500 and even greater. The elasticity of the mechanism is such that the value T′ has but little to play in the transmission of power.

The analysis brings us to determine the relation between the ratio of reduction r (quotient of mean angular velocity of driven shaft by angular velocity ω of driving shaft) and the quotient q of the resisting couple by the starting one.

When q is lower than but very near to unity, we get regimens of "disengaging" of a small interest because they correspond to too small values of the reduction ratio r, in practical cases when the whole index T′ is great.

With values of q even smaller, we get regimens to which we shall give the name of "pseudo-engaging": in these regimens shaft 3 has a continued movement, produced by periodical impulsions of shaft 2, which virtue of the mode of action of the filters occur without any shock.

The state of "pseudo-engaging" is this which give to the assembly of devices its efficiency: they produce the whole series of reduction ratios from the driving coupling produced when the value q corresponds to a fraction of millimeter. The value q for the driving coupling (engaging) depends beside essentially on index T of shaft 2.

Thus, filter C plays a fundamental part: it is in virtue of its effects that we can get, when in practical case the index of the whole is great, firstly, regimen of "pseudo-engaging," and then, of "engaging" (driving coupling) when the resisting couple becomes reduced enough.

In fact, Figure 6 on plate 1 shows the practical transmissions of power when in "pseudo-engaging" condition (sliding coupling), with the assembly of devices, and for the following data (evaluations being understood: masses in kilograms and length in centimeters): speed OV of driving shaft=1,000 revolutions per minute,

$$K=2M\times L\times R=180$$

$$\Gamma \text{ maximum}=\frac{K}{2}\omega^2=90\omega^2$$

We have taken successively $C_1=190$, $C_2=240$ and $C_3=300$; so that the index of shaft 2 is for each case respectively:

$$T_1=\frac{190}{180}=\frac{19}{18},\ T_2=\frac{240}{180}=\frac{4}{3},\ T_3=\frac{300}{180}=\frac{5}{3}$$

On the other hand, the index of the whole T′=300. At last, shaft 3 is rigid.

The curves V_1, V_2, V_3, correspond respectively to indexes T_1, T_2 and T_3.

It must be noted that when index of shaft 2 is nearer to 1, the curve becomes nearly a rectilinear one, and that there is a feeble variation of the resisting couple from the immediately appreciable starting of shaft 3 to the coupling one in R_1.

But as soon as the index of shaft 2 becomes nearer to the value 2, the curves are bending their first half part, then increasing their bending course, they end in every case with a nearly straight part. In the three hypotheses considered, the starting couple remains always equal to $90\omega^2$.

It is also seen that the part played by index T of shaft 2 in the variation of couple at the moment of "engaging" (driving) and also the power transmitted are quickly decreasing as T comes nearer to value 2. This remark allows us to get at wall and within suitable limits, variations of the point corresponding to the "engaging" (driving coupling).

Curves S_1 and S_2 shown in Figure 7 plate 2 represent the powers practically transmitted when in regimen of "pseudo-engaging" with a rigid shaft 3, having the same data as previously given, and with T=4/3 (speeds of motor equal to 1500 and 2000 revolutions per minute respectively). When rigid shaft 3 is substituted by a torsion one, the previous curves are modified as shown by the dotted ones S'_1 and S'_2 which only exist when the reduction ratio r remains inferior to ½ nearly.

These curves possess the following properties confirmed by calculations:

1°—With a rigid shaft 3, and for the same reduction ratio, the powers transmitted, when in "pseudo-engaging, are the ones to the others as the cubes of the speeds of this shaft.

2°—With a torsion shaft 3 the previous ratio increases while the reduction one remains inferior to ½. This increase depends:

(a) On the possibility of torsion of shaft 3 within limits permitting to avoid breaking.

(b) On the ratio of the speeds of the motor shaft.

Thus, for

$$\frac{ON}{OB}=\frac{OM}{OA}$$

we have: with a rigid shaft 3:

$$\frac{N_1N}{M_1M}=\frac{ON^3}{OM_3}$$

If this shaft shows any torsions, we have:

$$\frac{N_2N}{M_2M}>\frac{ON^3}{OM^3}$$

Particularly the points A_1, B_1, etc. ; ; are such that in all cases we have

$$\frac{B_1B}{A_1A}=\frac{OB^3}{OA^3}$$

They belong therefore to a curve P of the form $y=\alpha x^3$, which it will be easy to construct if one of the points are known. This curve determines, for the system under consideration, the powers at the moments of "engaging."

During the period of "engaging" or direct drive, which is corresponding, for example, to a speed of 1500 revolutions per minute of the motor, the power transmitted changes according to the line AA_1A_2, the point A_2 being defined by the couple maximum

$$\Gamma=\frac{K}{2}\omega^2$$

of the system which is also the starting couple, and thus we have:

$$A_2A=\frac{K}{2}\omega^3$$

In this regimen, for a resisting couple

$$\psi>\frac{K}{2}\omega^2$$

the apparatus breaks off and the shafts 2 and 3 take rapidly the rest position.

The lines such as B_2B, A_2A, are the ones to the others as the cubes of the angular velocities of motor shaft, that which enables us to write

$$\frac{B_2B}{A_2A}=\frac{OB^3}{OA^3}$$

Curve P_1, representing the maximum powers when in driving couple (engaging) is therefore easily constructed.

The curves P and P_1 are the boundaries of the three distinct regions T_1, T_2 and T_3.

Within region T_1 the powers transmitted, in state of equilibrium, occur necessarily when in regimen of "engaging" or direct drive, for the representative points can belong but to fractions of lines such as A_1A, B_1B, etc.

Within region T_2 it is possible to transmit powers in state of equilibrium, either when in regimen of "engaging" (direct drive) or when in regimen of "pseudo-engaging". In this case, effectively, the points may indifferently belong either to fractions of lines such as A_1A_2, B_1B_2, etc., or to fragments of curves S_1, S_2, etc. comprised between the principal curves P and P_1.

For this region one can easily pass from the direct drive regimen to the high ratio one; for that, it is sufficient to break down the established equilibrium by getting a rapid variation of the speed of the motor, either by accelerating if the motor does not give its whole power, or, in the other case, by firstly momently diminishing and then accelerating the speed.

It is seen, at last, that within the region T_3, the powers transmitted in state of equilibrium, are necessarily so when either on a regimen of "pseudo-engaging" or on a high ratio one.

This being said, let us consider now Figure 8, plate 3, in which are represented: the curve $OC_1I_1F_1$ of the powers of motor when fully loaded; the curve of the corresponding specific consumptions, with the point I_2 as minimum; and the curve of utilisation of the car when on flat.

Let us take on curve $OC_1I_1N_1$, a point G of which the absciss OD is comprised between OF and OI, these latters giving speeds which by the whole opening of the main admission valve of the motor, correspond on one hand to the maximum of efficiency, and on the other hand to the minimum of consumption by HP hour. The choice of this point is left to the appreciation of the builder who will tend to have it nearer to F_1 for a racing car or to bring it back to I_1 for an utilitarian vehicle.

In all cases, the point G being determined as also the various elements before examined, it is possible to draw the curves P and P_1 already defined, the curve P passing by the point G.

The regions T_1, T_2, T_3, shown in Figure 7 are in this case clearly defined.

Thus region T_1 will be the curvilinear triangle TF_1G bounded at the top by the part of curve GF_1 as for the single regimen of direct drive possible, the maxium power transmitted changes as that of motor when full loaded. On the other hand, the power required for the car cannot be inferior than the curve of utilisation on flat, unless on a declivity.

Region T_2 covers the curvilinear quadrilateral surface $OTGC_1$ and the curvilinear triangle C_1GH. The boundary at the top is formed by the portion of curve GE_3H, defined by points such as E_3. This latter represents the intersection of the curve S_3 (which corresponds to speed OE of motor which has in this case a limit power EE_1) with the line E_1E_3 parallel to the axis OF.

Within the quadrilateral surface $OTGC_1$ the power can indifferently be transmitted either when on direct drive or on self high ratio regimen, because the curve of the motor C_1G remains unpassed. But on regimen of "pseudo-engaging" and for the triangle C_1GH the power will inevitably be transmitted.

Region T_3 is delimited to the left, either by a portion of the curve S_4 (rigid shaft **3**), or by a fraction of the curve S'_4 (torsion shaft **3**). The boundary at the top is formed by the prolongation E_3F_3 or E_3F_4 of the curve GE_3 exactly defined already.

Summarily, it is possible to transmit power in state of equilibrium either obligatorily when on direct drive within the dotted part, or at will when on direct drive or on self high ratio within the cross lined part, or obligatorily when on self high ratio within the lined surface, this last one being able to be stretched to the left under the effect of torsion shaft **3**.

Figure 8 shows that the point G defines by its absciss OD the theoretical speed below which it is possible to pass on full load from the direct drive to the self high ratio regimen. The point C_1 gives the speed OC below which, by wholly opening the admission valve it is obligatorily passed from the direct drive to the "pseudo-engaging" regimen. At last, the points F_3 or F_4 specify the limit inferior speeds OK or OL which can be taken by the car with maximum speed and power of the motor according that shaft **3** is rigid or shows any torsions.

It is easy to verify that these limits correspond to all desirable necessities and leave to the driver a large choice in the faculty of using when on rise either the direct drive or the self high ratio regimen.

These explanations permit to see that all the working conditions indicated at the outset are fulfilled by the assembly of devices. We shall even add that the starting couple, depending solely on ω^2, for a determined device makes possible the using of maximum without any risk of stopping short the motor, for this latter furnishes power only when the car has motion. On the other hand, when the speed of motor is slow, the carrying couple is easily annihilated by the action of brakes which thus permits the suppression of the clutch.

It is easily conceived that the driving of the car becomes thus very more agreeable.

At last, the self high ratio combined with a judicious choice of point G, previously defined, permits an appreciable economy of fuel, particularly on lumpy roads.

In the application on motor-car, the assembly of devices is always completed by a cardan joint, which mounted near the origin of shaft **3** enables this latter to follow the vertical displacements of the geared back axle. On the other hand, any reversing mechanism whatever, with a dead point, placed generally on shaft **3**, permits to obtain the reversing of running of the car and if wanted to make the motor completely free.

The no-reversing of the mechanical filters prevents any movement of the car when this latter, left with its motor stopped, tends to make intermediate shaft **3** to turn reversedly from its single direction. Thus, when on upward slope, any stopping, either wanted or no, does not require the acting of brakes to prevent the car to run back. It is also possible, without the aid of brakes to prevent any running of the car when on downward slope, by putting on the reverse.

Description of the first assembly of devices Plates 4 and 5 (Figures 9—10—11 and 12)

In order to facilitate the description of this first assembly, Figure 9 represents the two parts of a longitudinal section of the devices splitted through **42—42**; Figures 10 and 11, cross sections of Figure 9 through **43—43** and **44—44**, the latter showing a fractional part on a greater scale; and Figure 12 gives two views of plate springs.

At first sight, one sees the three shafts **1**, **2** and **3**, independent on the same axis.

Device A shown at bottom of Figure 9 is in this case constituted of two symmetrical connecting rods acting upon two eccentric carriages located within a hollow fly wheel.

The devices B and C, represented at the top of Figure 9, are concentrically fitted; B being the exterior and C the interior one. This arrangement permits to shorten the length of the device.

The motor shaft **1** is provided at its end with a fly-wheel formed by two disks **4** and **5**, secured together by two portions of a crown **6** and **7** which go into grooves **8'** and **9'** of the disks and receive the assembling gudgeons **10**.

The parts **8** and **7** leave between them two symmetrical windows **8** and **9** parallel to the axis of shafts. In the sides of these windows, mortises **11** are made so that they are facing two by two and which are receiving the blocks **12**, in hardened steel of T section. The blocks **12** being secured on parts **6** and **7** by means of the assembling gudgeons **13**.

The blocks **12** are forming two radial slides in which play freely the rollers **14** of the connecting rods **15**. The ends of these latters constitute quadrangular parts **16**, shaped as forks **17** receiving the shafts of rollers **14** generally constituted by ball or roller bearings. The lateral ends of the interior sides of the forks **17** into which partially enter the blocks **12**, perform the guiding of the connecting rods.

The reamings **19** made in the connecting rods **15** receive the eccentric carriages **20** forged and integral with shaft **2**. Small rollers **21** are distantly placed between the reamings **19** and the carriages **20**, laterally guided by the flanges **22**. This arrangement frequently employed on roller bearings permits to have for film of oil a small coefficient of friction. In the same purpose balls can also be used.

The connecting rods and the eccentric carriages are made of special steel with their working surfaces greatly hardened.

As already seen, shaft **2** has on it the two carriages **20** of the same eccentricity set exactly up at 180%. This shaft goes in and passes through the disks **4** and **5** of the fly-wheel and turns on the ball bearings **23** and **24**.

The devices B and C are constituted of the fixed collar bracket **25** shut by the covers **26** and **27**, the whole forming a tight box.

The right hand cover **26** is provided with a bronze plug **28** and a roller bearing **29**, acting as guides and brackets of shaft **2**; this latter having on its left hand extremity a muff 30 of which the prolongation forms the hollow cylinder 31.

The left hand cover 27 is also provided with a bronze plug 32 and a roller bearing 33, acting as guides of shaft 3. The cylindrical cup 34 which ends the shaft 3 enters freely into the hollow shaft 31 and receives the end of shaft 2 by means of the ball bearing 35.

Within the fixed collar bracket 25 is placed a bush 36 having on each of its extremities a series of claws 37 which enter into claws similarly shaped made on interior flanges of the covers 26 and 27, securing thus the bush with the covers.

The two washers 38—30 fitted within the covers act as lateral thrust bearing for parts turning inside the tight box.

The exterior of the cup 34 and the interior of the bush 38 are longitudinally castellated according to the profiles shown by Figure 11. Each groove receives two consecutive small rollers 40, kept in contact with the working surfaces by the flat springs 41 which take their fulcrums on the radiant flanges 42 of the grooves. This arrangement is furthermore included in a distinct Patent No. P. V. 12,515 taken in France on the January 25, 1940 (Driving Device in One Direction Only, for Important Couples, with Rapid Frequencies of Action at High Speed).

In the exposed application, shaft 2 can turn but only in the same direction F as does the motor shaft 1 and insures in that direction the driving of shaft 3.

The parts moving within the tight box have all their working surfaces greatly hardened.

The assembly of devices is completed by a forced lubrication system. Oil arrives within a groove of bronze plug 28, goes through passages made on shaft 3 and is distributed to all the shifting parts, then is projected or flows to the exterior.

A tight chamber, not shown on the drawings, receives this oil which after being filtered performs again and indefinitely the same circuit.

The working of this assembly is the previously exposed one.

Description of a second assembly of devices Plates 6 and 7 (Figures 13–14–15 and 16)

For this second assembly, Figure 13 represents a complete longitudinal section, splitted through 45—45, and Figures 14, 15 and 16 cross sections of Figure 13 through 46—46, 47—47 and 48—40 respectively. The two last fractional sections are drawn on a greater scale.

We find again at the bottom of Figure 13 the device A and at the top the devices B and C, which in this case are established the one after the other.

Here device A is sensibly the same as the one already described. The hollow fly-wheel is also formed by two disks 4 and 5 secured together by two portions of crown 6 and 7. We find again the two windows 8 and 9 parallel to the axis of shafts, and the blocks 10 of rectangular section, forming two by two the radial slides into which the rollers 11 and the connecting rod 12 are shifting.

The connecting rods are both maintained laterally the one by the other and by the interior faces of the disks 4 and 5; thus the guiding action being better, though of course insured by the blocks 10 as in the first assembly already described.

The reamings 13, with the flanges 14, made on the connecting rods, receive the eccentrical carriages 15 integral with shaft 2 by means of the small rollers 16 maintained laterally by the flanges 14.

Shaft 2 has its right hand end guided within the disk 4 by means of the roller bearing 17 and passes through the disk 5 by means of the bearing 16.

Left hand end of shaft 2 is provided with a connecting plate 19 receiving a long sleeve 20 at the end of which two series of claws 21 and 22 are made according to the profiles shown in Figures 15 and 16. In this case each claw receives three consecutive small rollers 23.

A fixed bracket sleeve 24 receives forcedly fitted on it a jacket 25 and the races of bearings 26, 27 and 28. The roller bearings 26 and 27 bearing and centering the long sleeve 20 inside the jacket. However for reasons of building and fitting up, the hub of roller bearing 27 is forcedly adjusted on a splitted ring 20 placed in a central groove of the sleeve 20.

Roller bearing 28 receives the end of the hollow cylinder 30, exterior and concentrical to the left hand part of the sleeve 20. This cylinder is secured on plate 31 integral with shaft 3 and is centered inside the sleeve 20 by means of the bearing 32. A stem 33, also integral with shaft 3, is provided with a thrust bearing 34 having its fulcrum on the interior flange of sleeve 20. This device completes the longitudinal connection between the shafts 2 and 3.

A cylindrical part 35 secured on the left end of bracket 24 insures the lateral holding of the races of bearings 27 and 28 and forms a chamber to receive the lubricating oil flowing and furthermore insures the keeping tight of the passage of revolving cylinder 30.

A washer placed to the right of bracket 24 insures the holding of the race of roll bearing 26.

The forced oil which arrives into bearing bracket 37 of shaft 1, penetrates successively into central holes bored on shafts 1 and 2. This oil is then distributed within the connecting rods and fills the inside of sleeve 20. The small holes bored on this sleeve are communicating with the small chambers provided between the rollers 23 and the radiant flanges of grooves 39. The result is that the forced oil which can flow towards the exterior through the holes 40 produces thus a slight thrusting effect behind each roller and thus insures to them a permanent contact with the working surfaces. Furthermore, the rollers 23 placed on the exterior of the castellated sleeve 20, during the acceleration of shaft 2, utilise their respective force of inertia so as to augment the efficiency of the engagings and disengagings respectively. These improvements are precisely indicated in the patent previously mentioned.

A tight chamber, not shown on the drawings, receives the oil which after being filtered performs again the same circuit.

The working of this second assembly remains the same.

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