

Dec. 24, 1940.

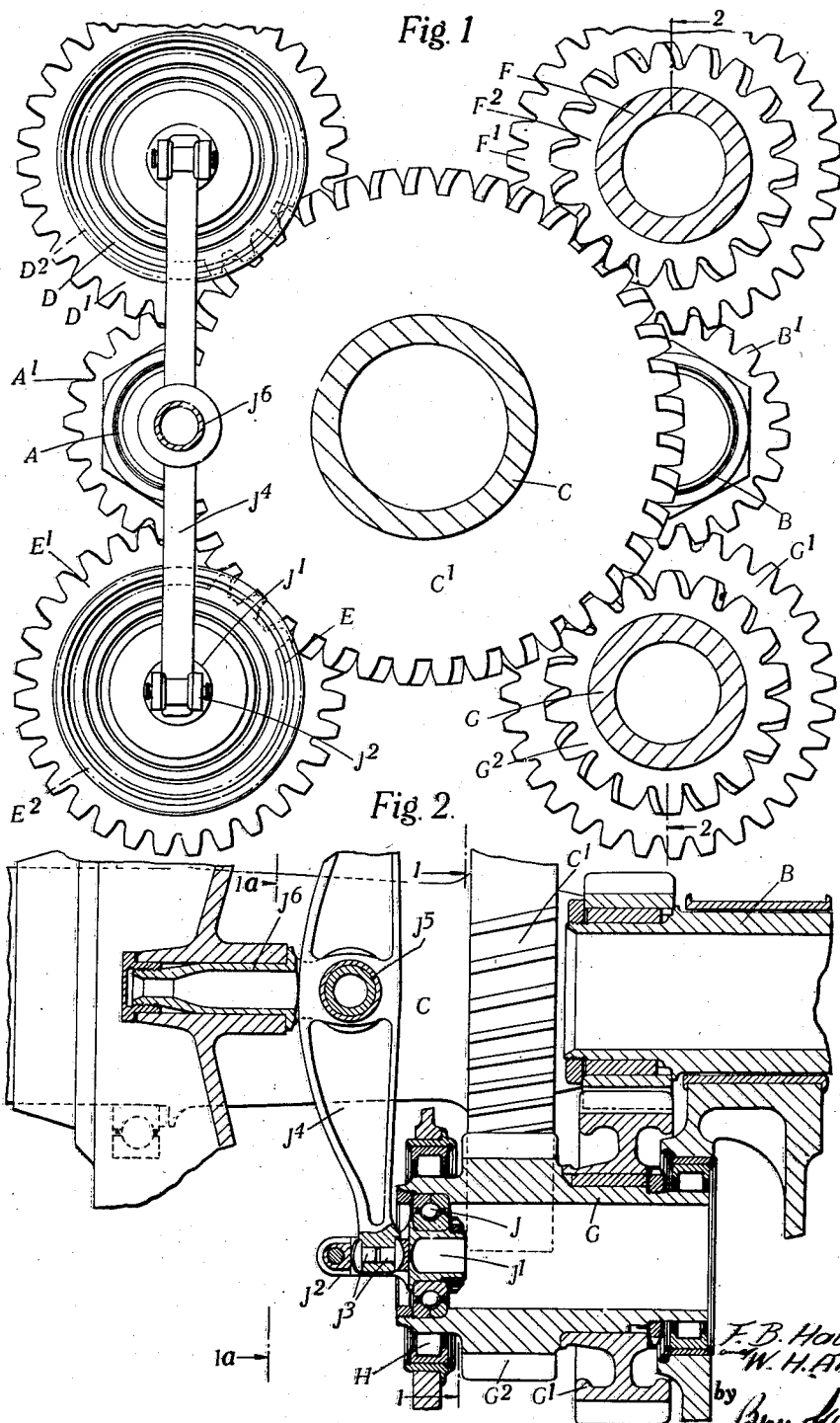
F. B. HALFORD ET AL

2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 1



Dec. 24, 1940.

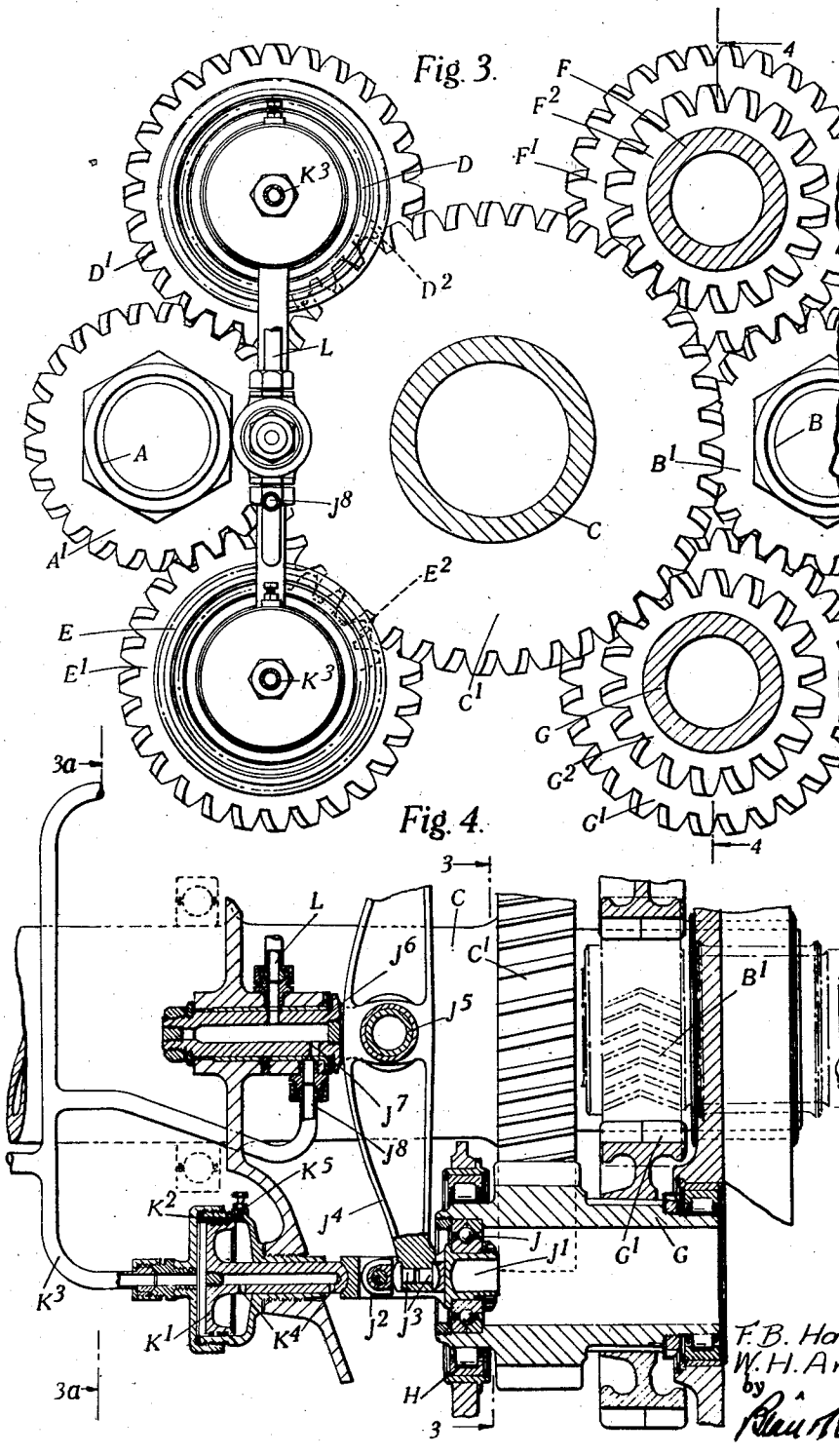
F. B. HALFORD ET AL

2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 2



Dec. 24, 1940.

F. B. HALFORD ET AL

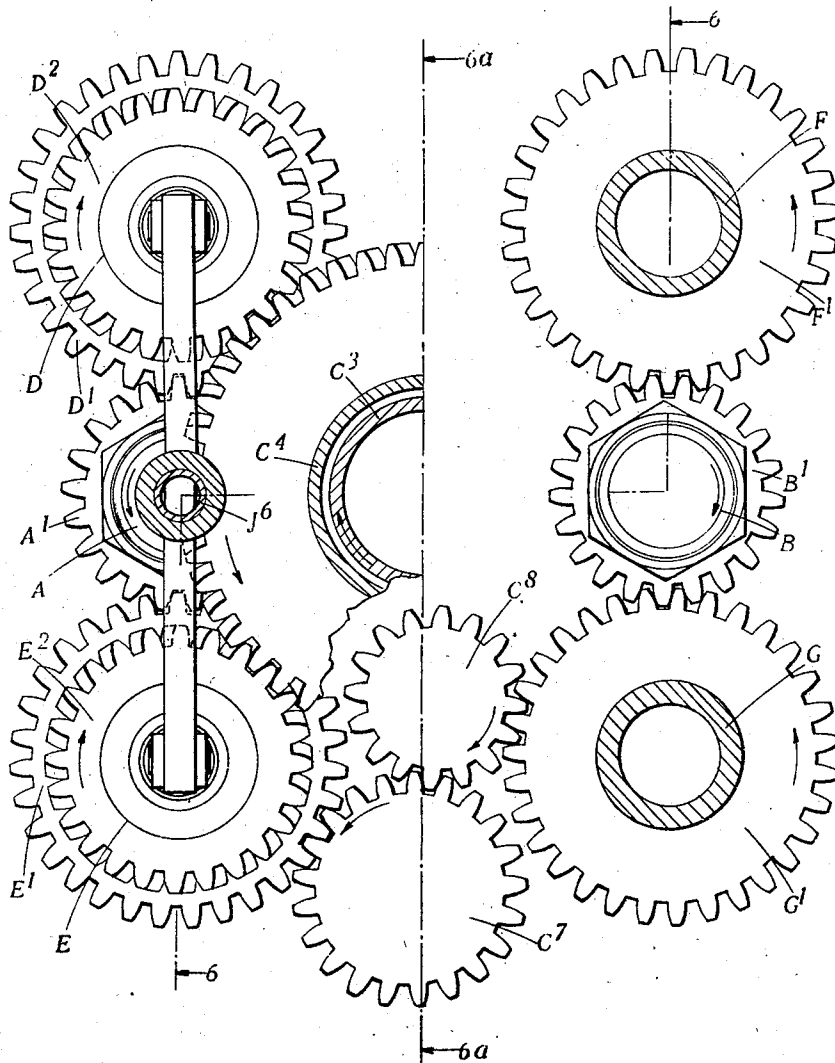
2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 3

Fig. 5.



Inventors

*F. B. Halford
and W. H. Arscott*

and W. H. Arscott

by

^{by}
Pearl Kelsey

Attorneys:

Dec. 24, 1940.

F. B. HALFORD ET AL

2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 4

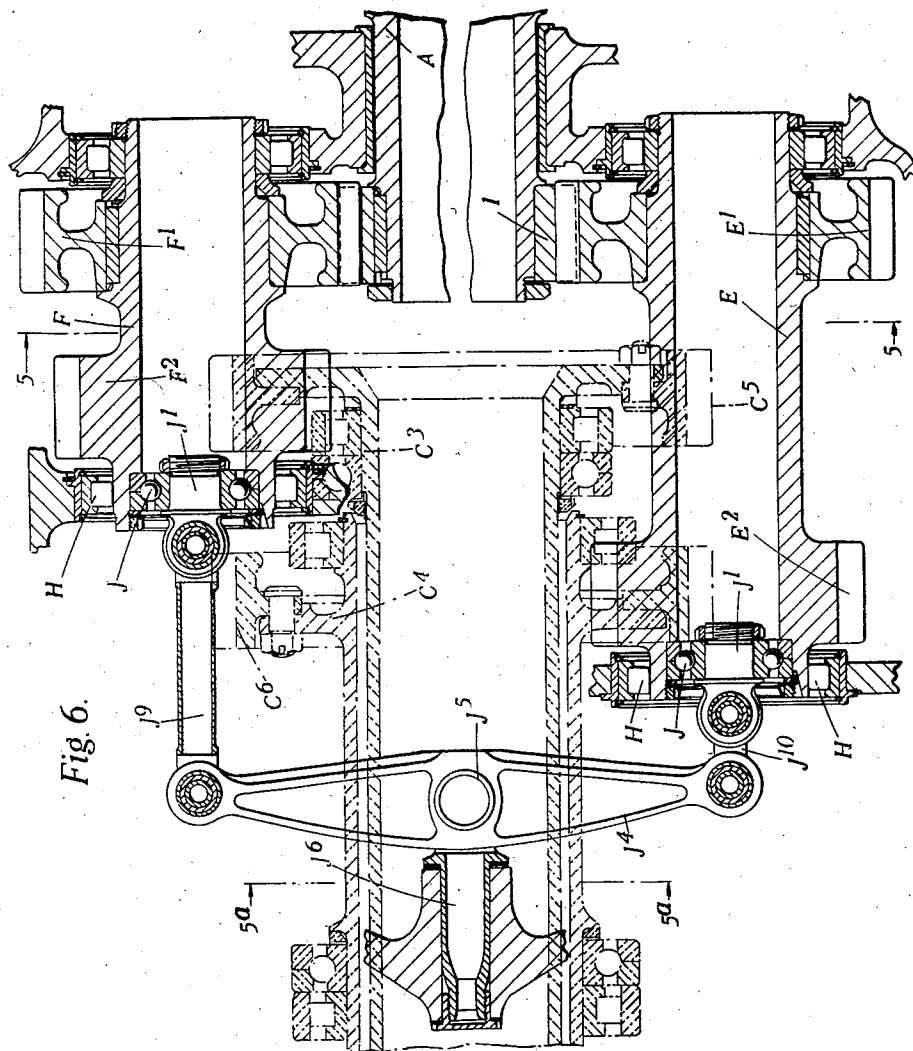


Fig. 6.

Inventors
F. B. Halford
and W. H. Arscott
by
Dean K. K. K.
Attorney

Dec. 24, 1940.

F. B. HALFORD ET AL

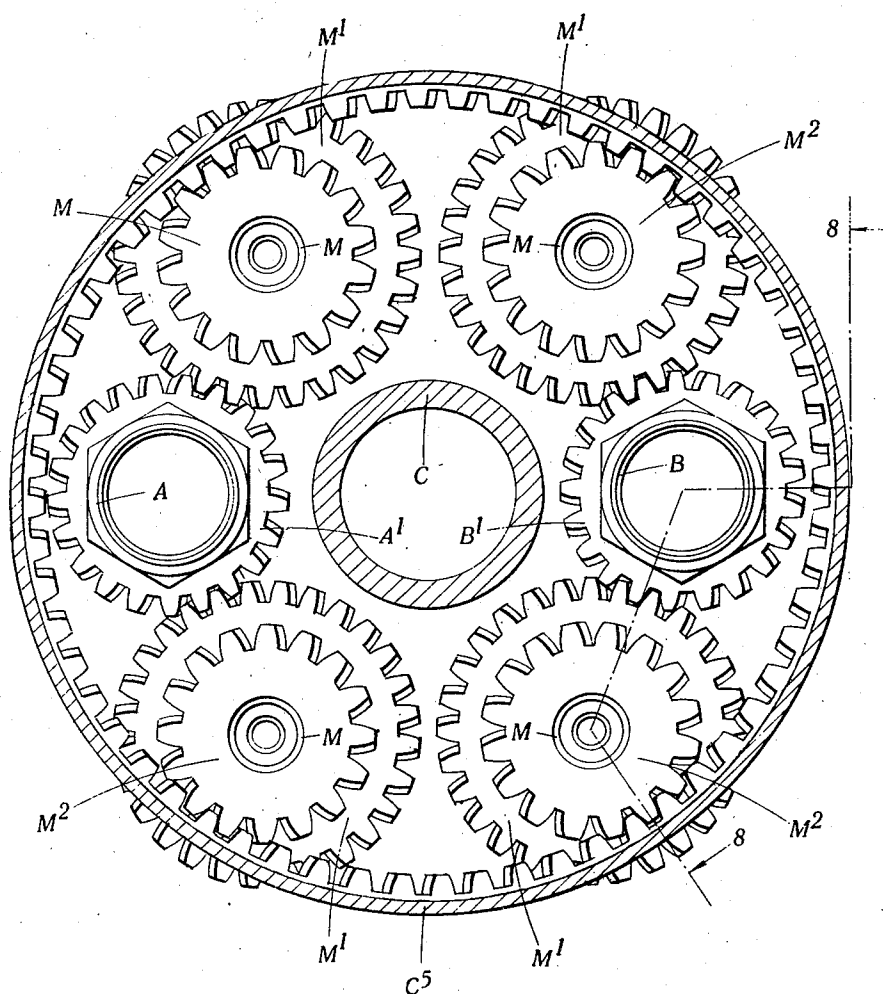
2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 5

Fig. 7.



Inventors
F. B. Halford
and W. H. Arscott
by
Alan Kelsey
Attorneys

Dec. 24, 1940.

F. B. HALFORD ET AL

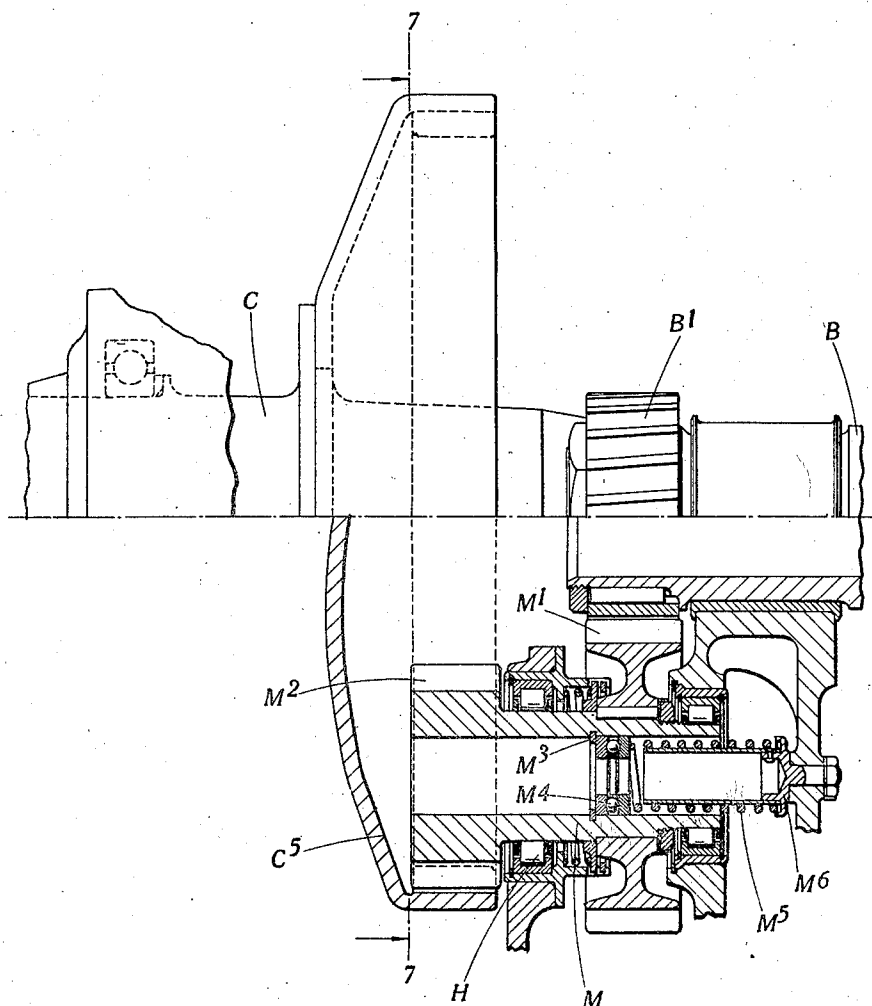
2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 6

Fig. 8.



Inventors
F. B. Halford
and W. H. Arkscott.
by
R. M. Kilgus
Attorneys

Dec. 24, 1940.

F. B. HALFORD ET AL

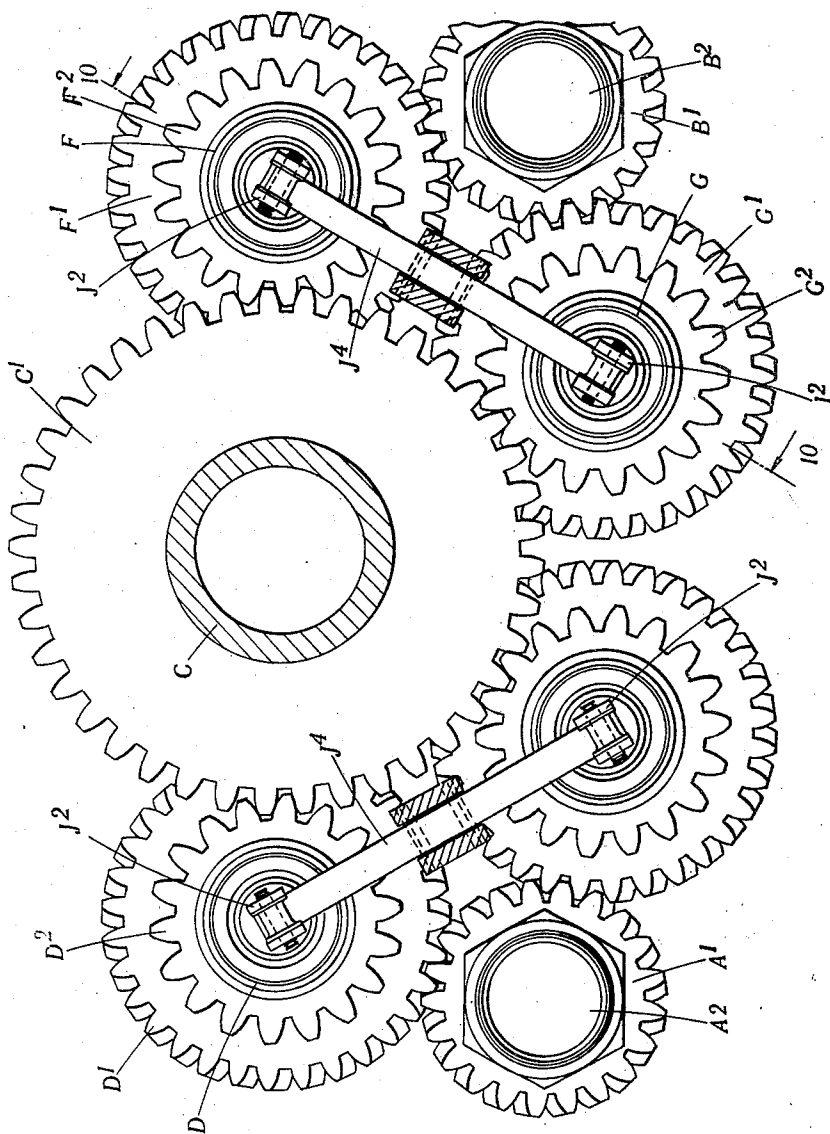
2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 7

Fig. 9.



Inventors
F. B. Halford
and W. H. Arscott
by
R. H. Kline
Attorney.

Dec. 24, 1940.

F. B. HALFORD ET AL

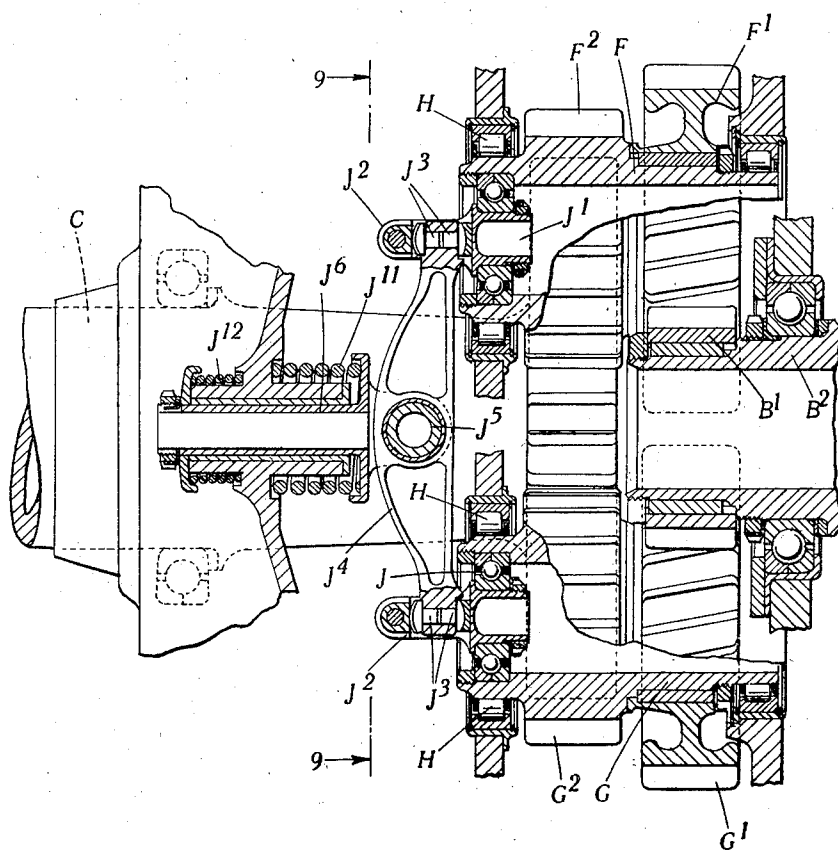
2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 8

Fig. 10.



Inventors
F. B. Halford
and W. H. Arscott
by
Ran. Kilgore
Attorneys

Dec. 24, 1940.

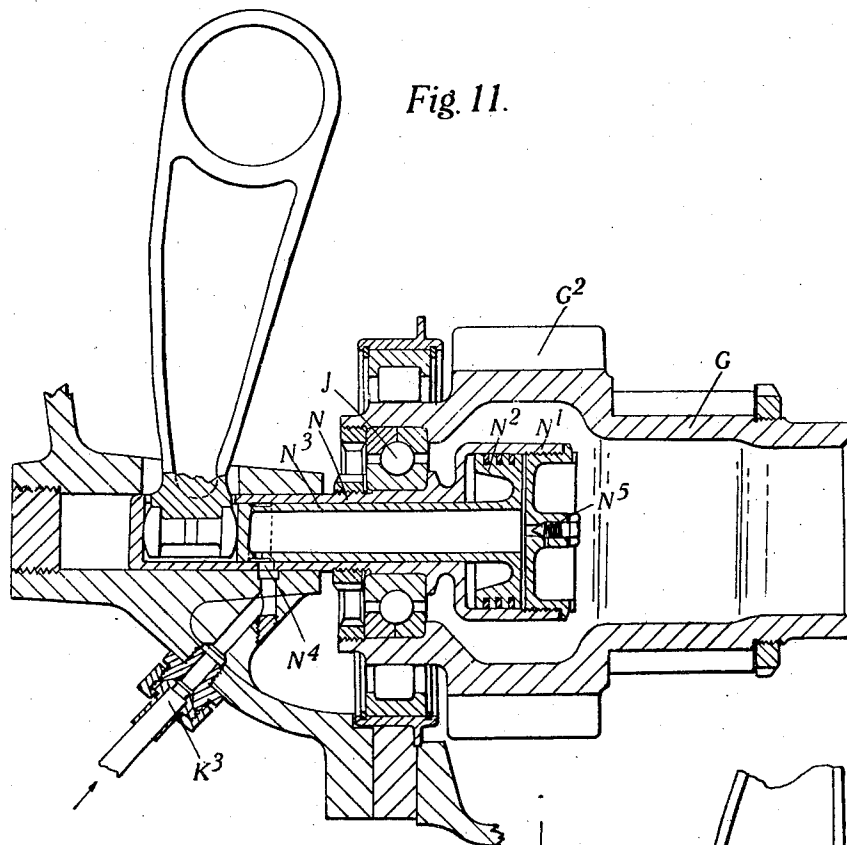
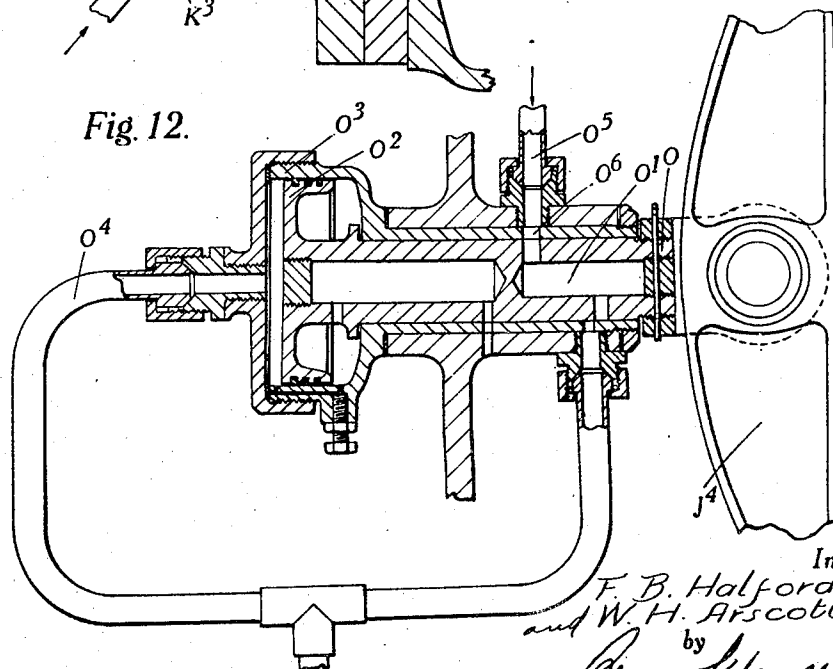
F. B. HALFORD ET AL

2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 9



Inventors
F. B. Halford
and W. H. Arscott
by
Robert H. Klemperer
Attorneys

Dec. 24, 1940.

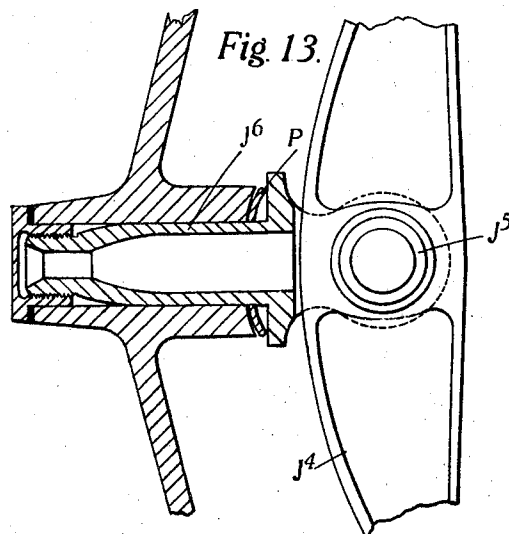
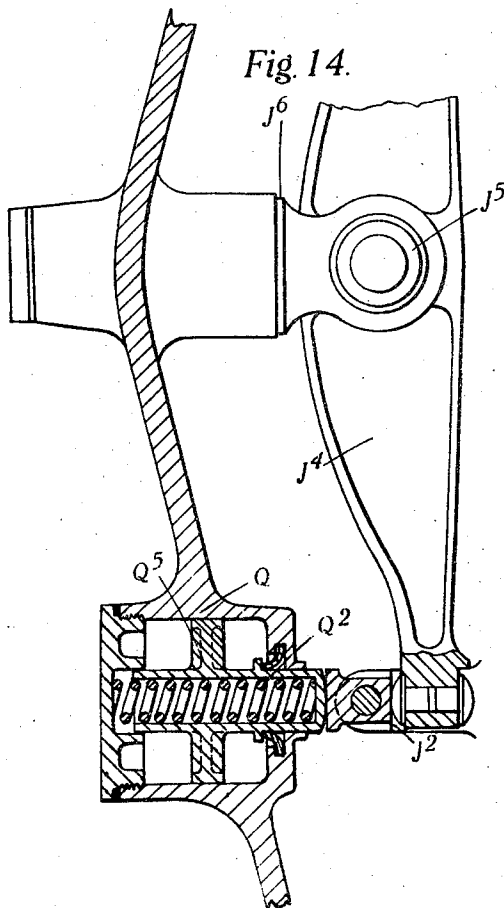
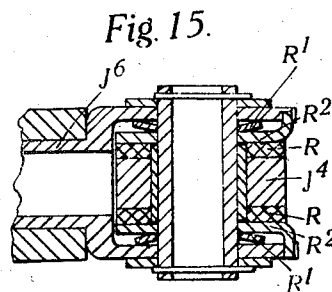
F. B. HALFORD ET AL

2,225,863

GEARING FOR TRANSMITTING POWER

Filed May 27, 1939

10 Sheets-Sheet 10



Inventors
F. B. Halford
W. H. Arscott
by
Alan H. Hays
Attorneys

UNITED STATES PATENT OFFICE

2,225,863

GEARING FOR TRANSMITTING POWER

Frank Bernard Halford, Edgware, and William Hammett Arscoff, London, England, assignors to D. Napier & Son Limited, London, England, a company of Great Britain

Application May 27, 1939, Serial No. 276,210
In Great Britain May 31, 1938

9 Claims. (Cl. 74-410)

This invention relates to gearing for transmitting power from a driving shaft to a driven shaft of the kind including two parallel layshafts each carrying gear wheels which mesh respectively with a gear wheel on the driving shaft and a gear wheel on the driven shaft, and is particularly but not exclusively applicable to gearing for transmitting power from two parallel driving shafts to a single driven shaft, for example from the two crankshafts of a two-crankshaft internal combustion engine to a single driven shaft connected to or carrying a propeller or airscrew.

The object of the invention is to provide improved gearing of the above kind in which inter alia any tendency for one layshaft to transmit more than its correct proportion of power will be eliminated.

To this end gearing for transmitting power from a driving shaft to a driven shaft which is parallel to but not coaxial therewith according to the present invention comprises a gear wheel on the driving shaft, a gear wheel on the driven shaft, two layshafts the axes of which are equidistant from the axis of the driving shaft and equidistant from the axis of the driven shaft, and a pair of gear wheels on each layshaft one of which meshes with a gear wheel on the driving shaft and the other with the gear wheel on the driven shaft, one or each of the two gear wheels on each layshaft having helical teeth so formed that during transmission of power there is a residual end thrust on at least one of the gear wheels on each layshaft, and means whereby the end thrusts on corresponding gear wheels on the two layshafts are approximately balanced against one another or are balanced against springs.

If desired the two layshaft gear wheels of a pair may be axially movable relatively to one another and either one or each of helical form in which case at least the gear wheels the axial thrusts of which are balanced against one another or against springs will be helical, the other gear wheel of each pair either being helical and held from axial movement by a thrust bearing or being a plain spur gear.

Preferably, however, the two gear wheels on each layshaft are rigidly connected together, in which case the residual end thrusts on the pairs of gear wheels will, of course, be balanced against one another or against springs.

In the case of springs, they will permit sufficient axial movement to each layshaft gear wheel or pair of layshaft gear wheels to provide an approximately equal distribution of power between

the layshafts. If, on the other hand, as is generally preferred, the end thrusts are balanced against one another, this may be effected either by a lever or levers or the like or hydraulically.

Preferably the axes of the two layshafts lie on diametrically opposite sides of the axis of the driving or of the driven shaft so as substantially to relieve that shaft from unbalanced lateral thrusts. Moreover, one of the pair of gear wheels on each layshaft is preferably a plain spur gear and the other a helical gear so that the gear wheel meshing with the plain spur gears will be relieved from any end thrust.

As stated, the invention is particularly applicable to gearing for transmitting power between a single shaft and twin shafts lying parallel to and equidistant from the single shaft and, in this case, the gearing according to the invention comprises a gear wheel on each of the twin shafts, a gear wheel on the single shaft, four layshafts which are parallel to and equidistant from the single shaft and two of which are equidistant from each of the twin shafts, a pair of layshaft gear wheels on each layshaft one of which meshes with the gear wheel on the associated twin shaft while the other meshes with the gear wheel on the single shaft, one or each of the pair of gear wheels on each layshaft having helical teeth so formed that during transmission of power there is a residual end thrust on at least one of each pair of layshaft gear wheels, and means whereby the end thrusts on the layshaft gear wheels associated with each twin shaft are approximately balanced against one another or against springs.

Preferably in such an arrangement the two crankshafts associated with each of the twin shafts lie on diametrically opposite sides of the axis of the single shaft, and the axis of one layshaft associated with each twin shaft lies on the diametrically opposite side of the axis of the single shaft from the axis of one of the layshafts associated with the other twin shaft. Moreover, where, for example, the twin shafts are the two crankshafts of a two-crankshaft internal combustion engine, the gear wheels on the twin shafts are preferably plain spur gear wheels so that the twin shafts will be relieved from axial thrusts from the gearing, while the gear wheel on the single shaft, for example the airscrew or propeller shaft, is a helical gear. In any case, the means for balancing the end thrust of one layshaft gear wheel or pair of layshaft gear wheels against the end thrust of another layshaft gear wheel or pair of layshaft gear wheels

conveniently comprises a lever the ends of which act through thrust bearings respectively on the two layshaft gear wheels or pairs of layshaft gear wheels while it is pivoted at approximately its centre to a thrust-receiving supporting member which may, for example, be rigidly connected to a casing or frame supporting the gearing. Alternatively, the thrust-receiving supporting member may be connected to the casing through a spring connection so that the balancing mechanism also acts to absorb sudden loads on the gearing or to minimise synchronous torsional oscillations. Again, for the same purpose the lever may act on each layshaft gear wheel through a spring connection and with either of these proposals the spring connection may be of the non-linear type, that is to say the law relating the relative movement of the members between which the spring connection lies and the variations in the force exerted by the spring connection on these members is not a straight line law.

Again, the mechanism for balancing the end thrust of one layshaft gear wheel or pair of layshaft gear wheels against that of another layshaft gear wheel or pair of layshaft gear wheels may include fluid or solid friction damping means resisting vibratory movement thereof or, alternatively, may be spring-loaded or biased for the purpose of preventing vibratory movement thereof. Such a biasing may, of course, tend to cause a slightly greater proportion of power to be transmitted through one pair of layshaft gear wheels than through the other but this proportion will be small in proportion to the total power transmitted.

Again, there may be associated with or included in the means for balancing the end thrust of one layshaft gear wheel or pair of layshaft gear wheels against that of another layshaft gear wheel or pair of layshaft gear wheels, or for balancing the end thrust of a layshaft gear wheel or pair of layshaft gear wheels against a spring, means whereby this end thrust can be measured and indicated for the purpose of giving an indication of the torque transmitted by the gearing. Thus, where a lever is used to balance the end thrusts against one another, as mentioned above, the means for measuring and indicating the end thrust may comprise a piston and cylinder so arranged in the connection between one or each of the pairs of layshaft gear wheels and the lever or between the lever and its supporting member that when liquid is introduced into the cylinder the thrust will be transmitted through the liquid, means for adjusting the liquid pressure automatically in proportion to the thrust as by opening a port on movement under increased thrust, and means for measuring the liquid pressure.

The axes of the layshaft gear wheels may either lie outside or within the circumference of the gear wheel on the single shaft and it will be understood that where these axes lie within the circumference of this gear wheel the gear wheel will be internally toothed to engage the appropriately externally toothed layshaft gear wheels.

The invention may be carried into practice in various ways but a number of constructions according to the invention, together with various modifications thereof, are illustrated somewhat diagrammatically by way of example in the accompanying drawings, in which

Figure 1 is a sectional front elevation of one construction according to the invention, the right

half being a section on the line 1—1 of Figure 2 with part of the casing removed and the left half a section on the line 1a—1a of Figure 2,

Figure 2 is a section on the line 2—2 of Figure 1,

Figure 3 is a similar view to Figure 1 of an alternative construction, the sections being taken on the lines 3—3 and 3a—3a of Figure 4,

Figure 4 is a section on the line 4—4 of Figure 3,

Figure 5 is a similar view to Figure 1 of a still further construction, the sections being taken on the lines 5—5 and 5a—5a of Figure 6,

Figure 6 is a section on the line 6—6 of Figure 5 with certain parts shown in chain dotted line in section on a line 6a—6a of Figure 5,

Figure 7 is a similar view to Figure 1 of another construction, the section being taken on the line 7—7 of Figure 8,

Figure 8 is a section on the line 8—8 of Figure 7,

Figure 9 is a similar view to Figure 1 of a still further construction, the section being taken on the line 9—9 of Figure 10,

Figure 10 is a section on the line 10—10 of Figure 9, and

Figures 11–15 inclusive show various modifications which may be employed in structures according to the invention.

In the construction illustrated in Figures 1 and 2, which is intended for driving a propeller from the two parallel crankshafts of a two-crankshaft internal combustion engine in which preferably each cylinder associated with one crankshaft fires simultaneously with a cylinder associated with the other crankshaft, the apparatus comprises two crankshafts A and B arranged with their axes parallel to one another and lying on diametrically opposite sides of the axis of a driven shaft C constituting the propeller shaft. Lying with their axes on diametrically opposite sides of each crankshaft are two layshafts D, E, F, G, the axis of the layshaft D lying on the diametrically opposite side of the axis of the propeller shaft C from that of the layshaft G while the axis of the layshaft F lies on the diametrically opposite side of the axis of the propeller shaft C from the layshaft E.

The crankshaft A carries a plain spur gear wheel A¹ which meshes with gear wheels D¹, E¹ respectively on the layshafts D and E while the crankshaft B carries a plain spur wheel B¹ meshing with gear wheels F¹, G¹ on the layshafts F and G respectively.

The four layshafts also carry helical gear wheels D², E², F², G² which all mesh with a helical gear wheel C¹ on the propeller shaft C. The layshafts are mounted in roller bearings H in the crank case H¹ so as to be permitted limited axial movement and it will be seen that during transmission of power from the crankshafts to the propeller shaft there will be a residual axial thrust on each layshaft due to the helical form of the gear teeth on the gear wheels D², E², F², G² and C¹. The residual axial thrusts on the layshafts D and E are balanced against one another and the residual axial thrusts on the layshafts F and G are balanced against one another by the following mechanism which is shown for the layshafts F and G in Figure 2. Thus, each of the layshafts F and G is connected at its outer end through a thrust bearing J to a thrust member J¹ formed with a lug J² slotted and provided with curved bearing surfaces for pads J³ secured to the end of a lever J⁴ which is piv-

oted at J^5 to a member J^6 secured to the crank case. Thus the residual end thrust on the layshaft F is balanced by the lever J^4 against the corresponding end thrust on the layshaft G while the residual thrust on the layshaft D is similarly balanced against the corresponding end thrust on the layshaft E .

The construction shown in Figures 3 and 4 is generally similar to that shown in Figures 1 and 2 except that the layshafts D , E do not lie on diametrically opposite sides of the crankshaft A nor do the layshafts F and G lie on diametrically opposite sides of the crankshaft B .

Moreover, in this construction the gear wheels A^1 , B^1 , D^1 , E^1 , F^1 , G^1 are double helical, the gear wheels D^2 , E^2 , F^2 , G^2 and C^1 are single helical and the layshafts D , E , F and G are free to slide but not rotate relatively to the gear wheels D^1 , E^1 , F^1 and G^1 respectively. Further, means are provided for measuring the end thrust on one pair or both pairs of layshafts for the purpose, for example, of indicating the torque being transmitted, any differences in the power transmitted respectively from the two crankshafts A and B and so forth. To this end, each of the lugs J^2 is provided at its outer end with a curved surface on which bears the end of the piston rod K of a piston K^1 disposed in a cylinder K^2 the outer end of which is connected to a pipe system K^3 to which oil can be supplied under pressure. The piston rod K is formed hollow, as shown, and is provided with ports K^4 to permit free escape of any liquid which may tend to accumulate in the righthand end of the cylinder. Further, a small leak path of controllable dimensions is provided by a passage controlled by the adjustable valve K^5 , whereby liquid can flow continuously at a slow rate from the lefthand end to the righthand end of the cylinder K^2 .

The admission of liquid under pressure to the pipe system K^3 is controlled by a valve constituted by the member J^6 which, to this end, is mounted so that it can move to a limited extent within a bore in a housing secured to the crank case. Oil under pressure is delivered to this housing through a pipe L which communicates at its inner end with a bore in the interior of the member J^6 . Also formed in this bore is an outlet port J^7 which, when there is little or no axial thrust on the layshafts, occupies the position shown so as to be closed but which can be moved by axial thrust on the member J^6 to come into communication with a pipe J^8 constituting part of the pipe system K^3 . A pressure gauge communicates with this pipe system.

The operation of this apparatus is as follows. When power is being transmitted through the transmission gearing the residual end thrust on the layshafts is transmitted to the two ends of the lever J^4 and thus moves the member J^6 to the left so as to open communication between the port J^7 and pipe J^8 . Liquid under pressure is thus admitted to the pipe system K^3 and thus acts on the lefthand end of the piston K^1 to cause this piston to tend to force the two layshafts to the right in Figure 4. The liquid pressure is sufficient to move the two pistons to the right until the lever J^4 has been moved bodily to the right to a point at which communication between the port J^7 and the pipe J^8 is cut off or nearly cut off. A continual small leakage however occurs through the valve K^5 . In practice, therefore, the port J^7 remains open to such a small extent as merely to make up for the leak-

age through the valve K^5 . In any case it will be seen that at all times the pressure in the system K^3 is exactly proportional to the residual end thrust exerted by the two layshafts and the pressing gauge thus gives an indication of this end thrust and hence of the power being transmitted through the layshafts associated with the lever J^4 . By providing similar apparatus in association with each lever J^6 it will be seen that differences in the power transmitted from the two crankshafts to the propeller shaft will be indicated by differences in the readings of the two pressure gauges.

In the construction illustrated in Figures 5 and 6, the arrangement of the crankshafts and of the layshafts is generally similar to that illustrated in Figure 1 except that two of the layshafts, namely E and G , are longer than the other two layshafts D and F , while each layshaft is connected to the appropriate end of its lever by means of a link J^9 or J^{10} . Thus the links J^9 at the ends of one lever J^4 are longer than the links J^{10} at the ends of the other lever J^4 so as to make up for the difference in the lengths of the layshafts with which the two levers are respectively associated.

Moreover, in this construction two concentric propeller shafts C^3 , C^4 are provided each carrying a gear wheel C^5 , C^6 and the gear wheels D^2 , F^2 on the layshafts D and F mesh with the gear wheel C^5 on the propeller shaft C^3 while the gear wheels G^2 , E^2 on the layshafts G and E mesh with the gear wheel C^6 on the propeller shaft C^4 .

Further, in this construction the two crankshafts A and B rotate in opposite directions and drive the two propeller shafts C^3 and C^4 in opposite directions. Thus, in order to ensure synchronism between the two crankshafts, the layshafts E and G are coupled together by two idle spur gears C^7 , C^8 meshing with one another and each meshing with one of the spur gears E^1 , G^1 on the layshafts E and G .

Figures 7 and 8 show a modification in which two parallel crankshafts A and B drive a single propeller shaft C through four layshafts. In this construction each crankshaft carries a helical gear wheel A^1 , B^1 meshing with corresponding helical gear wheels M^1 on two layshafts M , the four layshafts being arranged so that each layshaft lies on the diametrically opposite side of the axis of the propeller shaft C from another layshaft. The layshafts M carry further helical gears M^2 which mesh with an internally toothed gear wheel C^9 secured to the propeller shaft. In this construction each layshaft has limited free axial movement and the two gear wheels M^1 , M^2 on each layshaft are so formed that there is a residual end thrust on the layshaft. These residual end thrusts are balanced against springs. Thus, a spring thrust ring M^3 lies in an internal groove in each layshaft and is acted upon through a thrust bearing M^4 by one end of a helical spring M^5 the other end of which bears on a fixed member M^6 on the crank case.

In the construction shown in Figures 9 and 10 the arrangement is generally similar to that shown in Figures 1 and 2 except that the crankshafts which in Figures 9 and 10 are designated A^2 and B^2 do not lie on diametrically opposite sides of the driven propeller shaft C nor does each pair of layshafts D , G and E , F lie on diametrically opposite sides of each crankshaft nor are the layshafts so arranged that each layshaft lies on the diametrically opposite side of the

driven shaft from another layshaft. Moreover, the gear wheel A¹ on the crankshaft A and the gear wheels D¹, E¹ on the layshafts D and E with which it meshes are helical while the gear wheel C¹ on the propeller shaft and the layshaft gear wheels D², E², F², G² with which it meshes are plain spur gears. Moreover, instead of each of the members J² to which a balancing lever J⁴ is pivoted being fixed, these members are capable of limited axial movement against the action of a spring J¹¹, a second or cushioning spring J¹² also being provided.

It will be understood that in each of the constructions described above, wherein the gear wheel carried by the propeller shaft or each propeller shaft is a helical gear wheel, the arrangement will be such that the thrust of the propeller will act in opposition to the end thrust due to the helical form of the gearing.

In a modification applicable to an engine having a single crankshaft, an arrangement similar to that shown in Figures 1 and 2 or in Figures 3 and 4 or in Figures 7 and 8 or in Figures 9 and 10 may be employed but with one of the crankshafts and the two layshafts associated therewith omitted.

Figure 11 shows a modification which may be adopted, for example, as an alternative to that shown in Figure 4, whereby a reading of the end thrusts acting on the layshafts can be obtained. To this end, instead of the parts J¹, J², J³, K, K¹, K², K⁴, K⁵ of Figure 4, each of the thrust bearings J is connected to a member N formed at one end with a cylinder N¹ in which is disposed a piston N² having a hollow piston rod N³ the outer end of which bears upon and transmits thrust to the appropriate end of the lever J⁴. The interior of the piston rod N³ is arranged to communicate through a port N⁴ in the member N with the pipe system K³ the pressure in which thus acts on the righthand end of the piston in Figure 11 so that end thrust is transmitted from the member N to the piston N² and hence to the lever J⁴ through the liquid in the cylinder N¹. A constant small but controlled leakage path is provided for liquid from the cylinder N¹ through a port N⁵. The supply of oil to the pipe system K³ is effected by apparatus arranged and operating in the same manner as the apparatus J⁶, L, J⁷, J⁸ of Figure 4.

It will thus be seen that thrust is always transmitted through the liquid in the cylinder N¹ and that the pressure of this liquid in the pipe system K³ is at any moment a measure of the torque being transmitted.

Figure 12 shows a further modification which may be applied to a construction similar to that shown in Figure 1 in which each lever J⁴ is pivoted on a member O constituting the end of a piston rod O¹ the piston O² on which is disposed within a fixed cylinder O³ to which liquid under pressure can be supplied through a pipe O⁴ under the control of a valve constituted by the piston rod O¹. Thus liquid under pressure is delivered by a pipe O⁵ to a port O⁶ in the bore in which the piston operates and thence through the interior of the piston rod to a port O⁷ which can by movement of the piston rod be brought into and out of communication with the pipe O⁴. Thus, when thrust is applied to the lever J⁴, it moves to the left to open the port O⁷ and thus admit liquid pressure to the cylinder O³. This moves the piston to the right until the port O⁷ closes or nearly closes and any increase in thrust will re-open the port to admit further liquid un-

der pressure. A constant leak path controlled by a valve O⁸ is provided so that in practice the port O⁷ remains just sufficiently open to make up for the leakage of oil through this leak path. A pressure gauge is connected to the pipe O⁴ and it will be seen that this gauge, by indicating the pressure in the pipe, will always give a reading proportional to the thrust on the lever J⁴ and hence to the torque being transmitted through the layshafts associated therewith.

In the modification shown in Figure 13, which may also be applied to a construction similar in other respects to that shown in Figure 1, the member J⁶ to which the lever J⁴ is secured is mounted to slide within a bore in the crank casing and a leaf spring P interposed between this member and the casing is provided to take the thrust imposed thereon by the lever. A curved surface is provided into contact with which this leaf spring progressively rolls under increased thrust so that the force exerted by the leaf spring is not proportional to the movement of the member under variations in thrust. In this way the natural period of vibration of the system varies with variations in the torque being transmitted whereby the occurrence of synchronous vibrations tends to be avoided.

Figure 14 shows a further modification which may be applied, for example, to a construction similar in other respects to that shown in Figures 1 and 2 wherein a dashpot device constituted by a cylinder Q and piston Q¹ and a spring Q² act on extensions of the lugs J² and thus serve to impose frictional fluid damping upon oscillations of the lever J⁴.

Finally, Figure 15 shows a modified pivotal connection which may be employed between the lever J⁴ and the member J⁶ to which it is pivoted wherein discs R of frictional material are pressed by springs R¹ acting through metal discs R² into close engagement with the sides of the lever J⁴ so as to resist oscillations of this lever.

It is to be understood that the constructions and modifications illustrated are given by way of example only and that each construction may be modified to suit requirements without departing from this invention.

What we claim as our invention and desire to secure by Letters Patent is:

1. Gearing for transmitting power between a single shaft and twin shafts lying parallel to and equidistant from the single shaft comprising a gear wheel on each of the twin shafts, a gear wheel on the single shaft, four layshafts which are parallel to and equidistant from the single shaft and two of which are equidistant from each of the twin shafts, a pair of layshaft gear wheels on each layshaft one of which meshes with the gear wheel on the associated twin shaft while the other meshes with the gear wheel on the single shaft, one of the gear wheels on each layshaft having a plain spur gear while the other has helical teeth so that during transmission of power there is a residual end thrust on the gear wheels with helical teeth and means whereby the end thrusts on the corresponding gear wheels on the two layshafts associated with each of the twin shafts are approximately balanced against one another.

2. Gearing for transmitting power as claimed in claim 1, in which the axes of the two layshafts associated with each of the twin shafts lie on diametrically opposite sides of the axis of the twin shaft.

3. Gearing for transmitting power as claimed 75

in claim 1, in which the axis of one layshaft associated with each twin shaft lies on the diametrically opposite side of the axis of the single shaft from the axis of one of the layshafts associated with the other twin shaft.

4. Gearing for transmitting power as claimed in claim 1, in which the gear wheels on the twin shafts are plain spur gears while the gear wheel on the single shaft is a helical gear.

5. Gearing for transmitting power as claimed in claim 1, in which the means for balancing the end thrust of one layshaft gear wheel or pair of layshaft gear wheels against the end thrust of another layshaft gear wheel or pair of layshaft gear wheels comprises a lever the ends of which act through thrust bearings respectively on the corresponding gear wheels on the two layshafts while it is pivoted at approximately its centre to a thrust-receiving member.

6. Gearing for transmitting power as claimed in claim 1, in which the thrust-receiving member is rigidly connected to a casing or frame supporting the gearing.

7. Gearing for transmitting power as claimed in claim 1, in which the mechanism for balancing the end thrust of one layshaft gear wheel or pair of layshaft gear wheels against that of the corresponding gear wheel or gear wheels on another layshaft includes fluid or solid frictional damping means resisting vibratory movement thereof.

8. Gearing for transmitting power as claimed in claim 1, in which the means for balancing the end thrust of one layshaft gear wheel against

the end thrust of another layshaft gear wheel comprises a lever the ends of which act through thrust bearings respectively on the corresponding gear wheels on the two layshafts while it is pivoted at approximately its centre to a thrust-receiving member, means for measuring and indicating the end thrusts comprising a piston and cylinder arranged so that liquid within the cylinder is subject to the end thrust, and means for measuring the liquid pressure within the cylinder.

9. Gearing for transmitting power between a single shaft and twin shafts lying parallel to and equidistant from the single shaft comprising a gear wheel on each twin shaft, a gear wheel on the single shaft, four layshafts which are parallel to and equidistant from the single shaft and two of which are equidistant from each of the twin shafts, a pair of layshaft gear wheels on each layshaft one of which meshes with the gear wheel on the associated twin shaft while the other meshes with the gear wheel on the single shaft, one of the gear wheels on each layshaft being such that transmission of power there-through produces no end thrust thereon while the other is of helical form, and means whereby the end thrusts on the corresponding helical gear wheels on the two layshafts associated with each of the twin shafts are approximately balanced against one another.

FRANK BERNARD HALFORD.
WILLIAM HAMMETT ARSCOTT.