No. 731,474. PATENTED JUNE 23, 1903.

L. J. LE PONTOIS.

ELECTRICALLY CONTROLLED SPEED CHANGING APPARATUS.

APPLICATION FILED DEC. 20, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

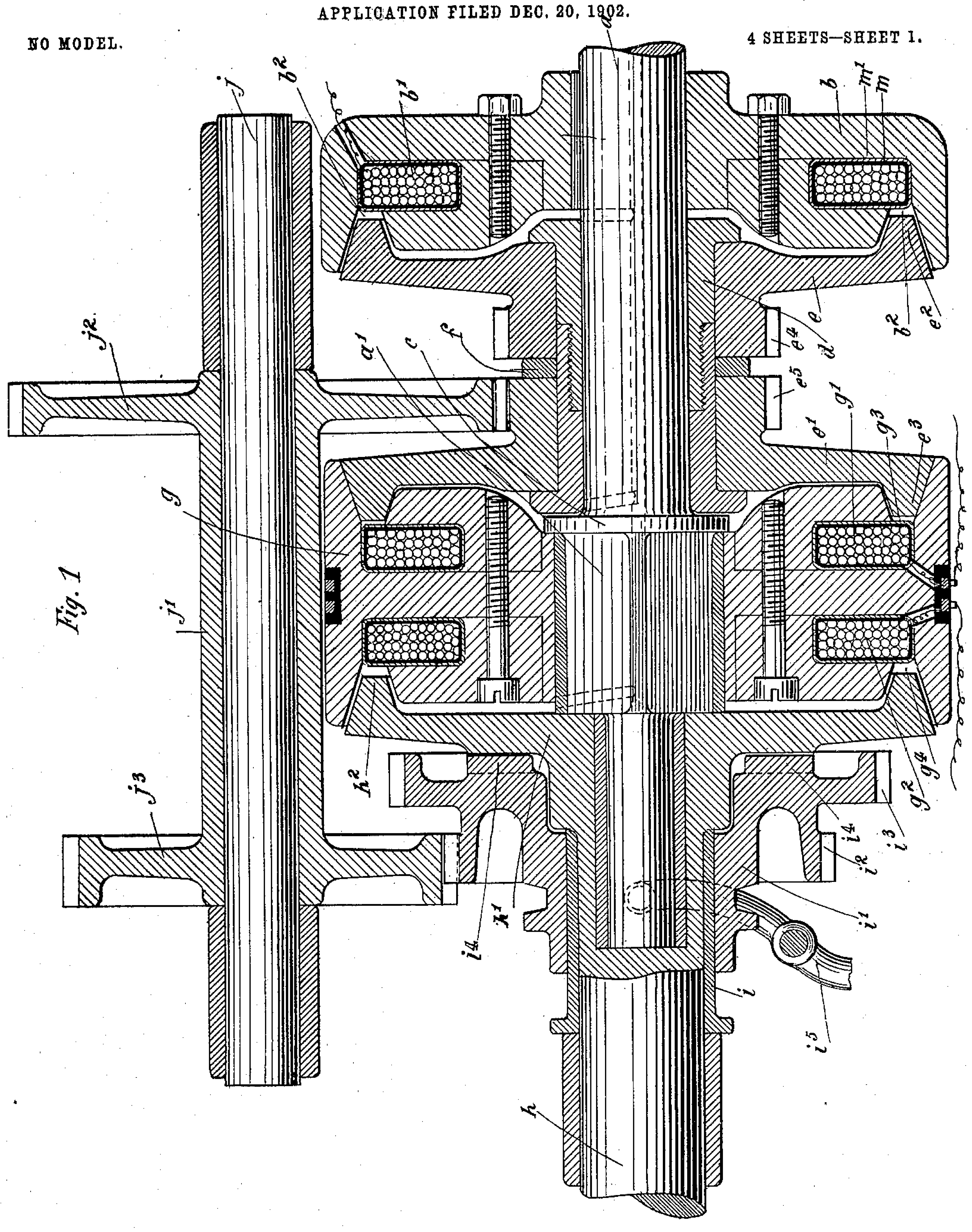


Fig. 1

WITNESSES:

H. Didier

Otto P. Ormers.

INVENTOR

Leon Jules Le Pontois

BY

Seabury C. Mastick

his ATTORNEY

No. 731,474. PATENTED JUNE 23, 1903.

L. J. LE PONTOIS.

ELECTRICALLY CONTROLLED SPEED CHANGING APPARATUS.

APPLICATION FILED DEC. 20, 1902.

NO MODEL. 4 SHEETS—SHEET 2.

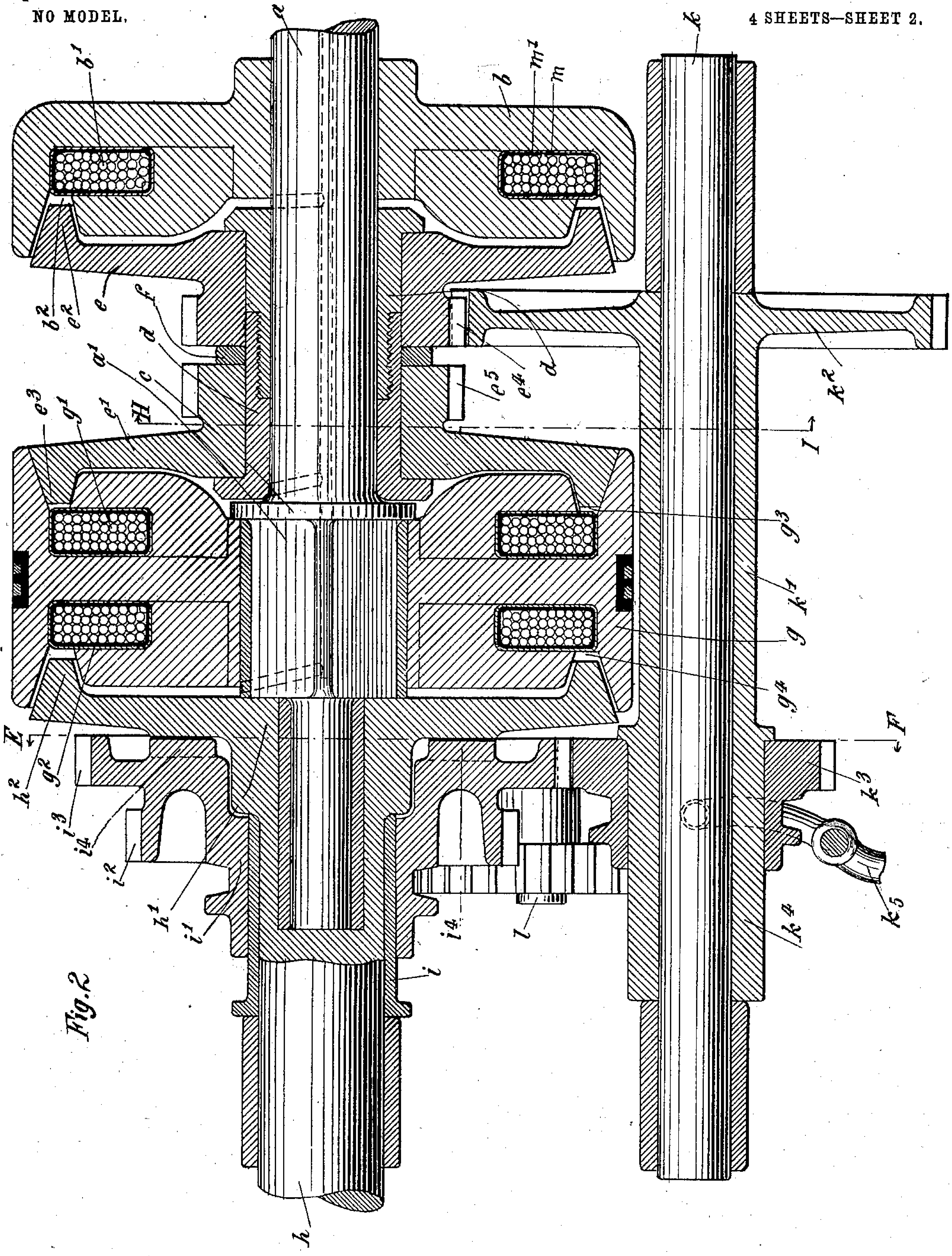


Fig. 2

WITNESSES:

A. Didier

Otto B. Osmers.

INVENTOR

Léon Jules Le Pontois

BY

Seabury C. Mastick

his ATTORNEY

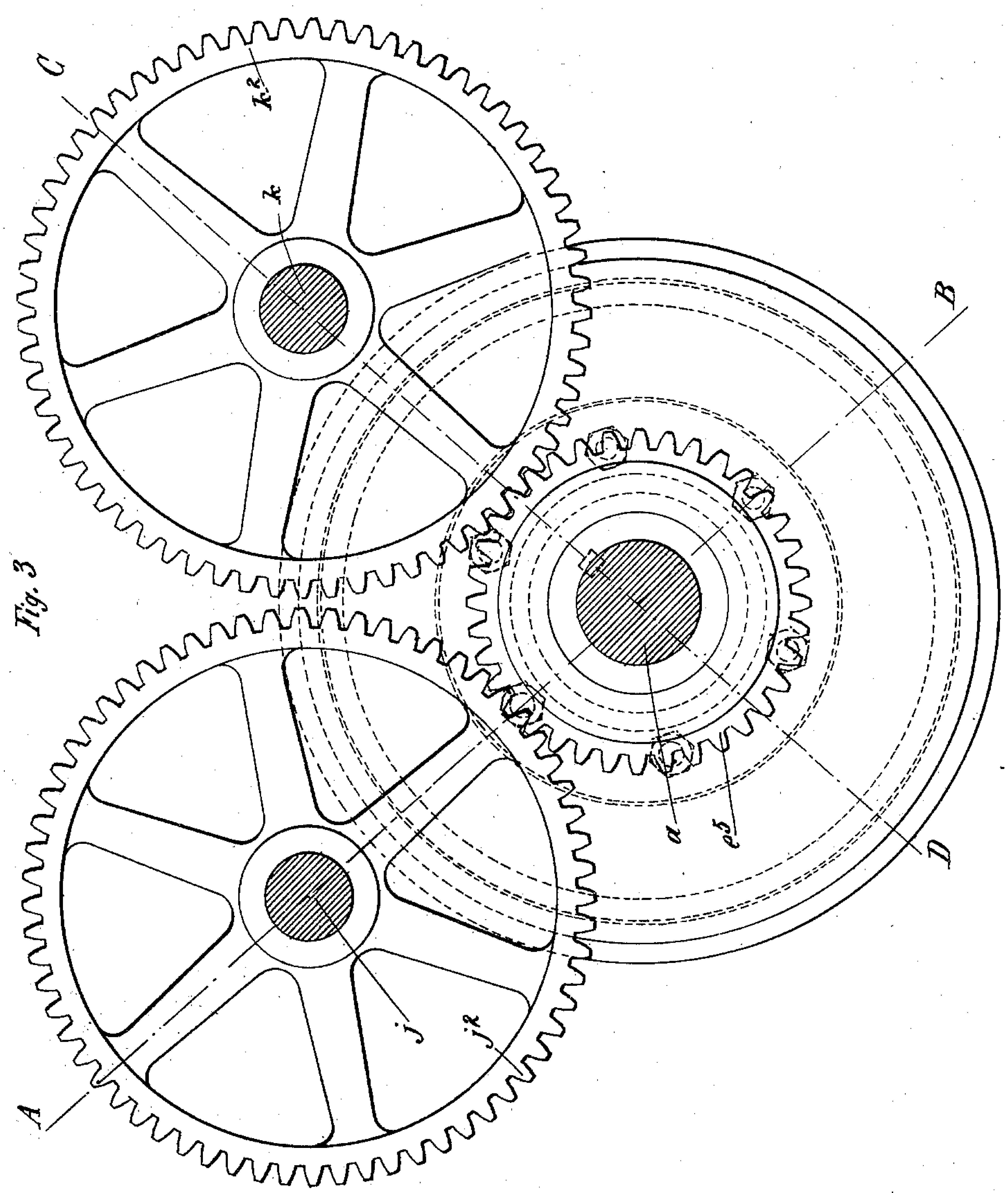
No. 731,474. PATENTED JUNE 23, 1903.

L. J. LE PONTOIS.

ELECTRICALLY CONTROLLED SPEED CHANGING APPARATUS.

APPLICATION FILED DEC. 20, 1902.

NO MODEL. 4 SHEETS—SHEET 3.



WITNESSES:

H. Didier

Otto F. Downers.

INVENTOR

Leon Jules Le Pontois

BY

Seabury C. Mastick

his ATTORNEY

No. 731,474. PATENTED JUNE 23, 1903.

L. J. LE PONTOIS.

ELECTRICALLY CONTROLLED SPEED CHANGING APPARATUS.

APPLICATION FILED DEC. 20, 1902.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 4

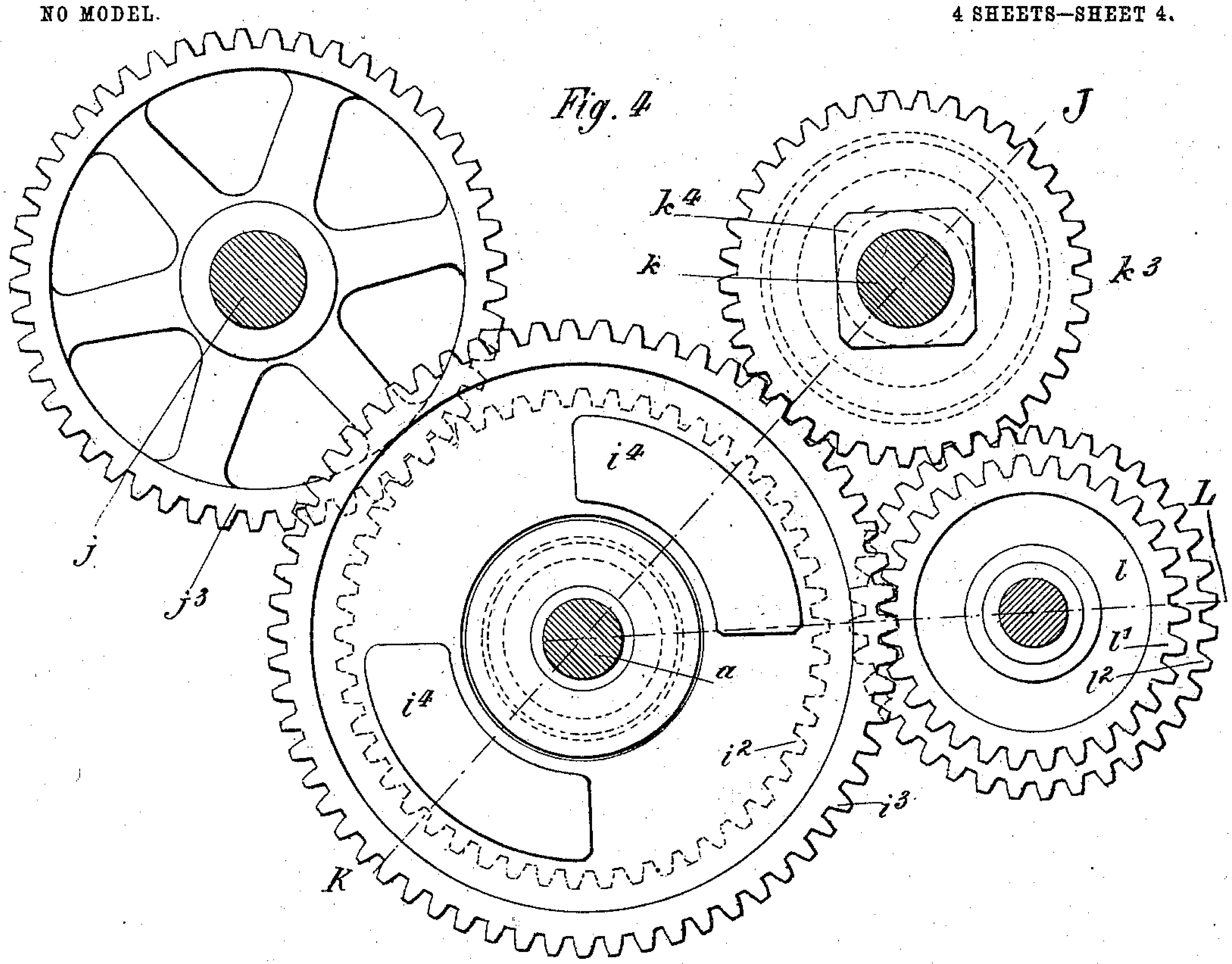
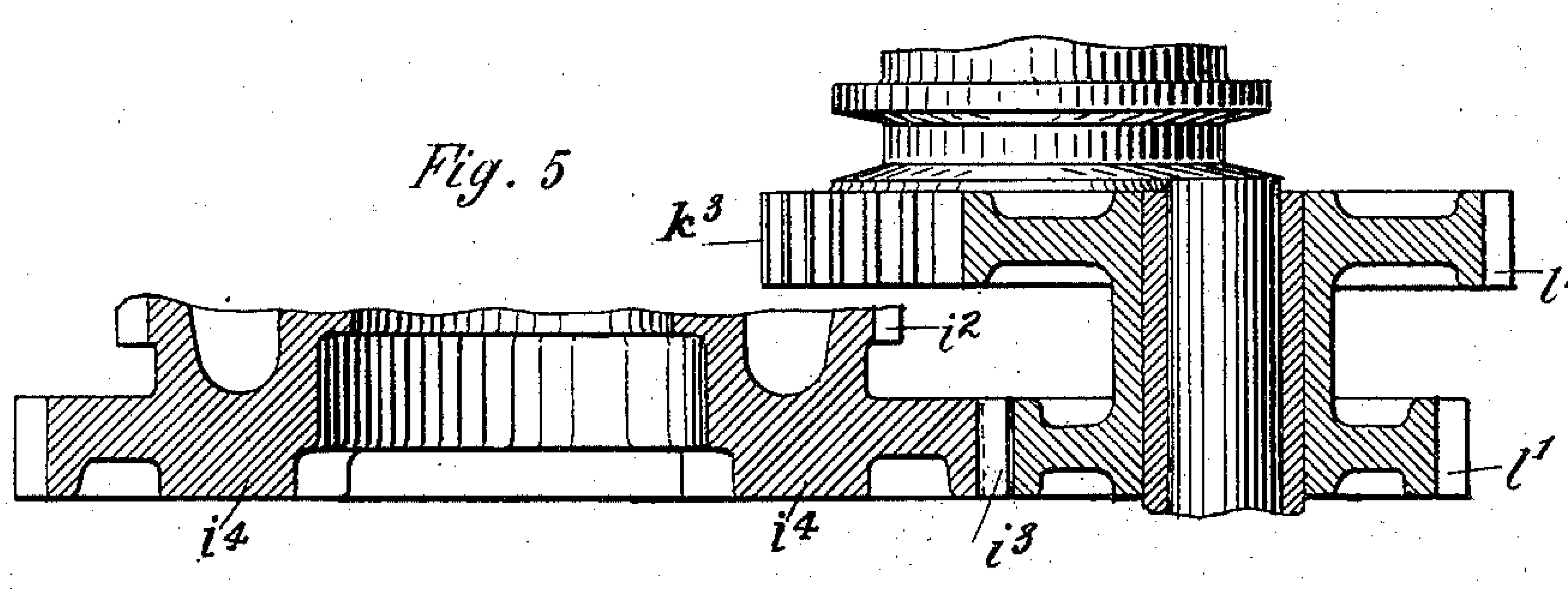


Fig. 5



WITNESSES:

INVENTOR

BY

his ATTORNEY

No. 731,474. Patented June 23, 1903.

UNITED STATES PATENT OFFICE.

LEON JULES LE PONTOIS, OF NEW YORK, N. Y.

ELECTRICALLY-CONTROLLED SPEED-CHANGING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 731,474, dated June 23, 1903.

Application filed December 20, 1902. Serial No. 136,016. (No model.)

To all whom it may concern:

Be it known that I, LEON JULES LE PONTOIS, a citizen of the Republic of France, and a resident of New York city, State of New York, have invented certain new and useful Improvements in Electrically-Controlled Speed-Changing Apparatus, of which the following is a specification.

My invention relates to new and useful improvements in electrically-controlled speed-changing apparatus, whereby the speed of the driven shaft may be varied or its direction of rotation may be reversed and the driven shaft may be connected with or disconnected from the driving-shaft.

The object of the invention is accomplished by combining electromagnetic friction-clutches with suitable gears, arranged as hereinafter described, so that the operation of parts and the suitable adjustment and intermeshing of the gears may be readily carried out, while the effect of residual magnetism is entirely obviated.

In the following I have described, with reference to the accompanying drawings, a construction embodying my invention, the features thereof being more fully pointed out hereinafter in the claims.

In the drawings, Figure 1 is a central lengthwise sectional view along the line A B of Fig. 3. Fig. 2 is a central lengthwise sectional view along the line C D of Fig. 3. Fig. 3 is a vertical sectional view along the line H I of Fig. 2 looking in the direction of the arrows. Fig. 4 is a vertical sectional view along the line E F of Fig. 2 looking in the direction of the arrows. Fig. 5 is a sectional view along the lines K J and K L of Fig. 4.

Similar letters indicate similar parts throughout the several views.

a indicates the driving-shaft, driven by any suitable means. (Not shown.)

b indicates an annular field-magnet keyed on the shaft *a*, having an annular coil b' in its periphery for magnetizing the same and provided on its inner face with an annular tapering groove b^2.

c indicates a shoulder on shaft *a*, and between said shoulder *c* and the magnet *b* is a sleeve or bushing *d*, adapted to turn freely on the shaft and at the same time to have lengthwise movement thereon between the shoulder *c* and the magnet *b*. On the sleeve *d* are mounted two annular armatures *e* and e', adapted to turn freely thereon and to turn each independent of the other. Between the two armatures *e* and e' is a suitable washer *f*, adapted to keep the armatures from contact with each other and to provide a smooth surface against which each of the armatures may turn. Each of the armatures *e* and e' is provided with an annular tapering rim e^2 and e^3, respectively, adapted to coact with and fit into the corresponding groove in the respective field-magnet opposite its armature, the field-magnet operating with armature e' being hereinafter described. Said armatures *e* and e' are also provided with pinions e^4 and e^5, respectively, to operate as hereinafter set forth, each pinion being preferably cast integral with its respective armature.

A portion of the driving-shaft *a* is square in cross-section, as at a', and on this squared portion is mounted a double annular field-magnet *g*, adapted to turn with the shaft *a* and to have lengthwise movement thereon. The field-magnet *g* is provided with coils g' and g^2 in its periphery for magnetizing the respective faces thereof and is also provided in its faces with annular tapering grooves g^3 and g^4, respectively. The annular tapering groove g^3 is adapted to coact with the annular tapering rim e^3 of armature e', as shown.

h indicates the driven shaft. On its inner end and preferably integral therewith is an armature h', provided with an annular tapering rim h^2, adapted to coact with and fit into the annular tapering groove g^4 in the double field-magnet *g*. The inner end of the driving-shaft *a* finds a bearing in the driven shaft *h*, as shown, the parts being thus kept in the proper alinement.

i is a sleeve on the driven shaft *h*, adapted to form a bearing for sleeve i', having pinions i^2 and i^3 preferably cast integral therewith. The inner face of the pinion i^3 is provided with projections i^4 i^4, adapted to engage and interlock with corresponding recesses in the face of armature h' when thrown into engagement therewith by means of lever i^5. Said lever is supported in any suitable manner independent of said moving parts. When disengaged from armature h', the sleeve i', of which pinion i^3 forms a part, rotates freely on sleeve i.

j is a counter-shaft mounted in any suitable manner, forming a bearing for sleeve j', provided with pinions j^2 and j^3, preferably integral therewith, pinion j^2 being adapted to gear with pinion e^5 on armature e' and pinion j^3 being adapted to gear with pinion i^2 on sleeve i'.

k is a counter-shaft supported in any suitable manner, forming a bearing for sleeve k', provided with pinions k^2 and k^3. The pinion k^2 is adapted to gear with pinion e^4 on armature e' and is preferably cast integral with the sleeve k'. The portion of shaft k forming a bearing for pinion k^3 is square in cross-section, as shown at k^4, so that while rotating therewith the pinion k^3 is adapted to lengthwise movement thereon. Lever k^5, suitably supported on means not connected with the moving parts, is adapted to give lengthwise movement to pinion k^3.

Mounted on a suitable support independent of the moving parts is an idler l, provided with gears l' and l^2, l' being adapted to intermesh with pinion i^3 and gear l^2 being adapted to intermesh with pinion k^3. The gear l' is always in engagement with pinion i^3, while gear l^2 is normally disengaged from pinion k^3 and is engaged therewith only when the latter has been moved into engagement therewith lengthwise on sleeve k' by means of lever k^5, and hence out of engagement with pinion i^3, so that the motion of pinion k^3 is transmitted to pinion i^3 through the idler l instead of directly, thus reversing the motion.

The operation of the apparatus is as follows: If an electric current is sent through coil b', field-magnet b is energized and attracts armature e to it, the tapering groove b^2 and tapering rim e^2 fitting into each other, and thus, by reason of the tapering construction, placing the parts in the path of as many lines of magnetic force as is possible. The attracting of armature e to the field-magnet b pulls sleeve d along shaft a, and hence armature e' away from the corresponding face of double field-magnet g. Armature e will then turn with field-magnet b on shaft a and through pinions k^2 and k^3 on shaft k. k^3 being in mesh with pinion i^3 will turn pinion i^3. Lever i^5 having been turned to interlock pinion i^3 with armature h' by means of projections i^4 i^4, fitting into the corresponding recesses in armature h', driven shaft h will be rotated in a forward direction at the slowest speed. Now if the current is cut off from the coil b' and sent through the coil g' in the face of double field-magnet g, adapted to coact with armature e', that face of the field-magnet will be magnetized and will attract armature e' to it and through sleeve d, moving on shaft a away from field-magnet b, will pull armature e away from the field-magnet b, overcoming any effect of residual magnetism in field-magnet b. Armature e' then moving with field-magnet g will, through pinions j^2 and j^3 on shaft j and pinion i^2 on sleeve i', the sleeve being interlocked with the armature h' by means of projections i^4 on pinion i^3 being engaged with the corresponding recesses in armature h', as hereinbefore described, drive the driven shaft h at a greater rate of speed than when armature e is moving with field-magnet b, as hereinbefore described. Now if current is cut off from coil g' and is sent through coil g^2 the other face of field-magnet g is magnetized and field-magnet g is pulled away from armature e' along shaft a and attracted to armature h', thus transmitting the motion of shaft a directly to armature h', which forming a part of the driven shaft h moves the latter forward at the speed of the driving-shaft—that is, the highest speed.

For reversing the direction of the driven shaft h pinion k^3 is moved lengthwise on shaft k by means of lever k^5, disengaged from pinion i^3 and engaged with gear l^2 of idler l. The motion then transmitted by pinion k^3 by means of said idler l is the reverse of the motion when pinion k^3 is directly in gear with pinion i^3, thus turning the driven shaft h in a backward or reverse direction at the slowest speed.

If it is desired to drive the driven shaft at the highest speed for a considerable length of time, the pinion i^3 should be disengaged from the armature h', the gear-wheels then remaining stationary and the driving-shaft driving the driven shaft directly, as hereinbefore described. Thus all noise due to the running of gears when not doing work is suppressed, and no power is spent in driving them.

The apparatus is preferably inclosed in a box or case filled with oil, so as to permit a certain slip or sliding contact of the clutches, as it would be impossible to bring the driven shaft from no speed to any speed at all without causing undue strain on the gear-wheels unless some such provision was made.

In order to cause almost instant demagnetization of the field-magnets and to obviate the effect of the current induced in the coils when the current is broken, which would otherwise tend to prolong the magnetic induction and added to the residual magnetism increase the difficulty of breaking the armature away from the magnet, and also in order to prevent the high potential difference which would otherwise exist between the terminals of the field-coil, resulting in a current capable of destroying the contacts and endangering the insulation of the generator furnishing the exciting-current, I have provided means to partly neutralize the effect of the induced current. To accomplish this purpose, the coil having been first carefully wound with insulating tape and mica, (indicated by m in the drawings,) I wind a thin flexible copper strip over the insulating material, soldering the ends of the copper strip together, so that the copper forms a continuous sheath around the coil. The copper sheath (indicated by m' in the drawings) thus constitutes a closed circuit, and the current induced in it by the field-discharge spends most of its energy in heating the sheath, which has a large radiating power, thus minimizing the effect of the induced current, owing to the small amount of self-induction in the sheath. The same effect, as is obvious, may be obtained by interposing a condenser in shunt with the terminals of the coil, in which case the condenser-discharge tends to demagnetize the field-magnet; but the arrangement first described is the most simple.

The apparatus as described is particularly adapted for use with self-propelled vehicles in which it is desirable to accelerate the motion progressively. A rheostat placed in series with the field-coils, in connection with the oil-bearings, will allow a certain slip of the friction-clutch, while not deteriorating in any way from the action of said clutches.

It is obvious that the details of construction may be varied and that the parts may be rearranged without departing from the spirit of my invention, and I do not restrict myself to the exact construction or device shown.

Having described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a speed-changing apparatus the combination of a driving-shaft, field-magnets turning therewith, one of said magnets being fixed on the shaft and another adapted to longitudinal movement thereon and means operated by said magnets for transmitting the power of the driving-shaft, for the purpose set forth.

2. In a speed-changing apparatus the combination of a driving-shaft, field-magnets turning therewith, an armature riding loosely on said shaft between said magnets adapted to longitudinal movement on the shaft and means operated by said armature for transmitting the power of the shaft, for the purpose set forth.

3. In a speed-changing apparatus the combination of a driving-shaft, field-magnets turning therewith, independently-rotatable armatures riding loosely on said shaft between said magnets adapted to longitudinal movement on the shaft and means operated by said armatures for transmitting the power of the shaft, for the purpose set forth.

4. In a speed-changing apparatus the combination of a driving-shaft, a field-magnet fixed thereon, a field-magnet adapted to turn with the shaft and to have longitudinal movement thereon, an armature riding loosely on said shaft between said magnets adapted to be attracted from one to the other and means operated by said armature for transmitting the power of the shaft, for the purpose set forth.

5. In a speed-changing apparatus the combination of a driving-shaft, a field-magnet keyed thereon, a field-magnet adapted to turn with the driving-shaft and to have longitudinal movement thereon, independently-rotatable armatures riding loosely on said shaft between said magnets adapted to longitudinal movement on the shaft, and means operated by said armatures for transmitting the power of the shaft, for the purpose set forth.

6. In a speed-changing apparatus the combination of a driving-shaft, field-magnets turning therewith, one of said magnets being adapted to longitudinal movement on said shaft, an armature riding loosely on said shaft between said magnets adapted to longitudinal movement on said shaft, a driven shaft, an armature on said driven shaft adapted to coact with the movable magnet and means operated by said armatures for transmitting varying speeds to the driven shaft.

7. In a speed-changing apparatus the combination of a driving-shaft, a field-magnet keyed thereon a field-magnet turning therewith adapted to longitudinal movement thereon, independently-rotatable armatures riding loosely on said shaft adapted to longitudinal movement thereon and to be attracted against said magnets, a driven shaft, an armature on said driven shaft adapted to attract said movable magnet and means operated by said armatures for transmitting varying speeds to the driven shaft.

8. In a speed-changing apparatus the combination of a driving-shaft, a double field-magnet adapted to turn therewith and to have longitudinal movement thereon, a driven shaft, an armature on said driven shaft on one side of said magnet adapted to attract said magnet when one of its faces is magnetized and an armature on the other side of said magnet adapted to attract said magnet when the other of its faces is magnetized, for the purpose set forth.

9. In a speed-changing apparatus the combination of a driving-shaft, an electromagnetic clutch turning therewith, independently-supported rotatable means having one pinion fast thereon and another turning therewith but capable of longitudinal movement thereon, means for transmitting motion from the clutch to the fixed pinion, a driven shaft and means for transmitting motion from the movable pinion to the driven shaft whereby the direction of rotation of the latter may be reversed.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

LEON JULES LE PONTOIS.

Witnesses:
OTTO P. OSMERS,
SEABURY C. MASTICK.