No. 755,504. PATENTED MAR. 22, 1904.

C. F. LAUR & A. E. ROBINSON.

VARIABLE SPEED MECHANISM.

APPLICATION FILED OCT. 19, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

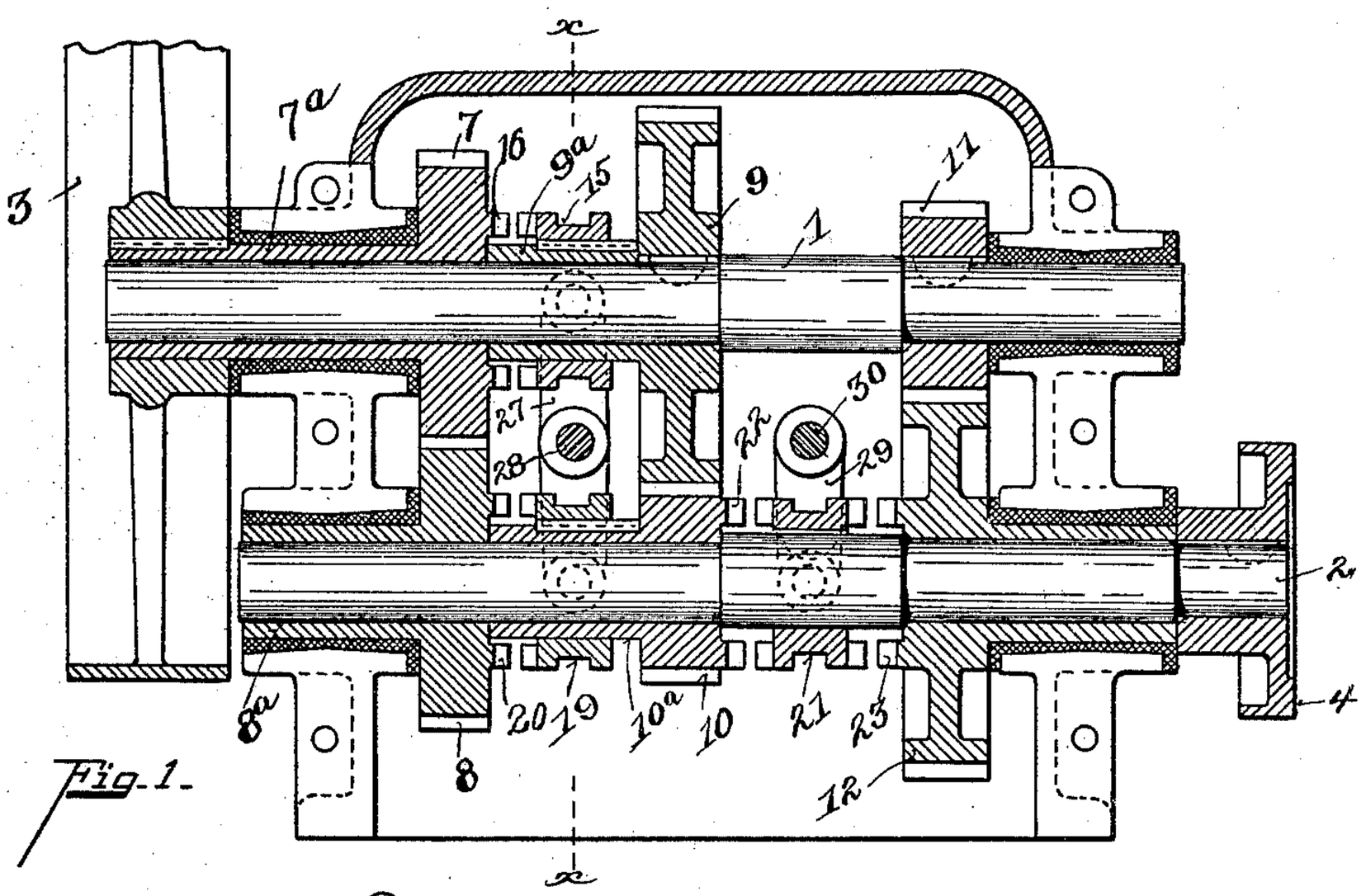

Fig. 1.

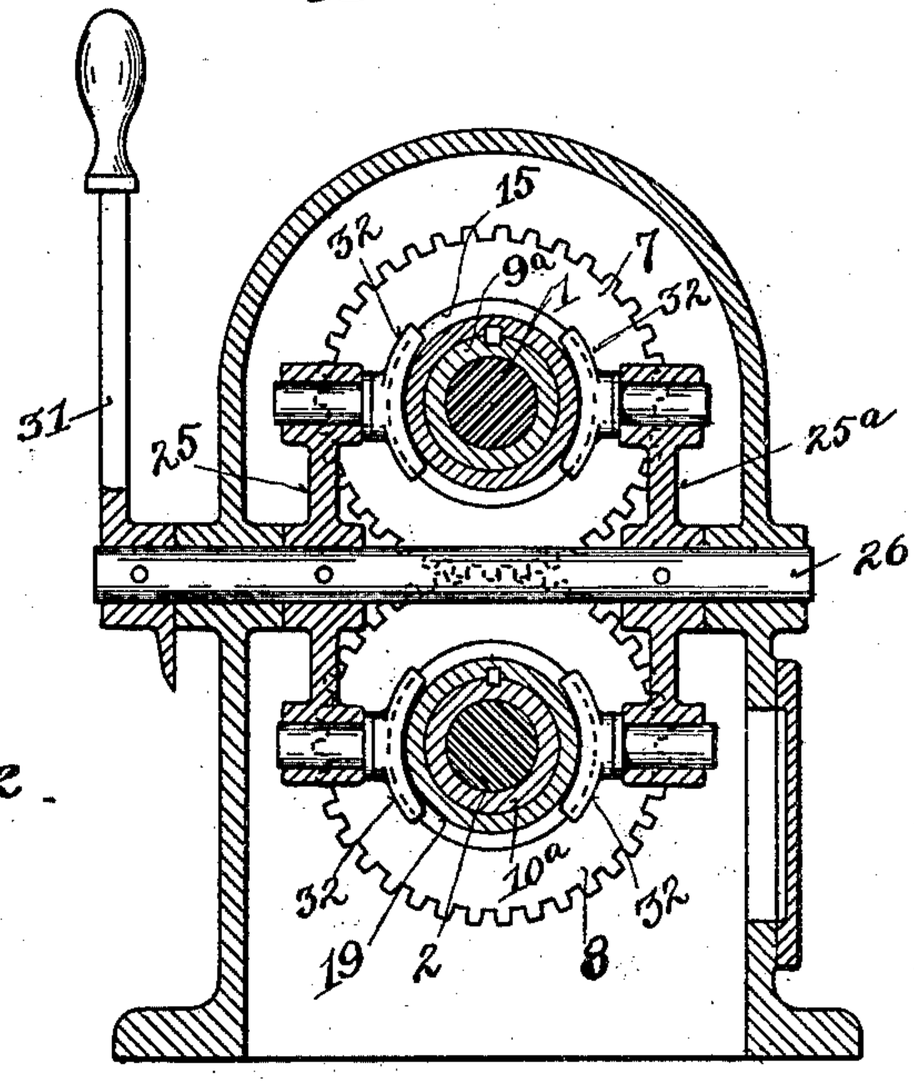

Fig. 2.

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NO MODEL. 2 SHEETS—SHEET 2.

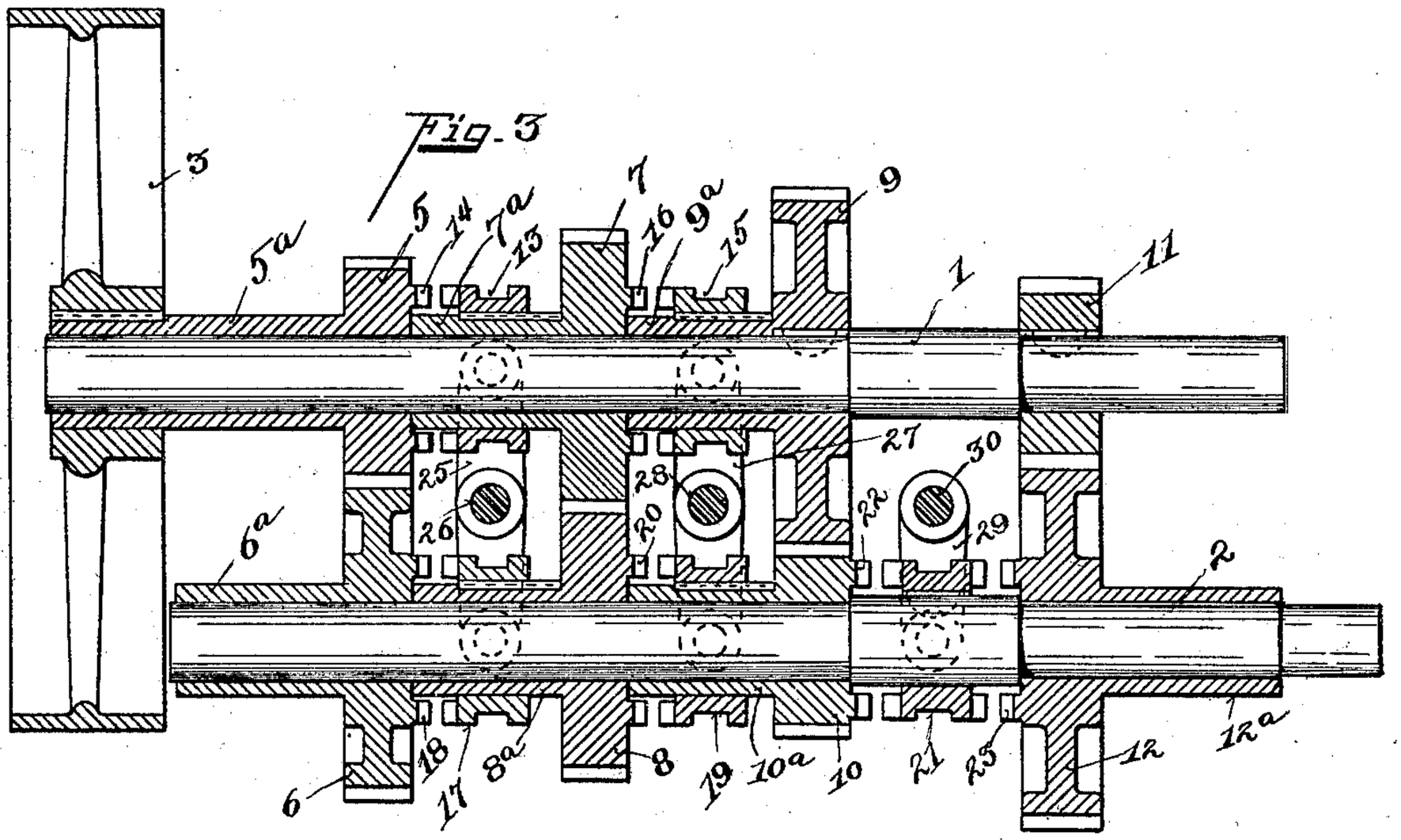

Fig. 3.

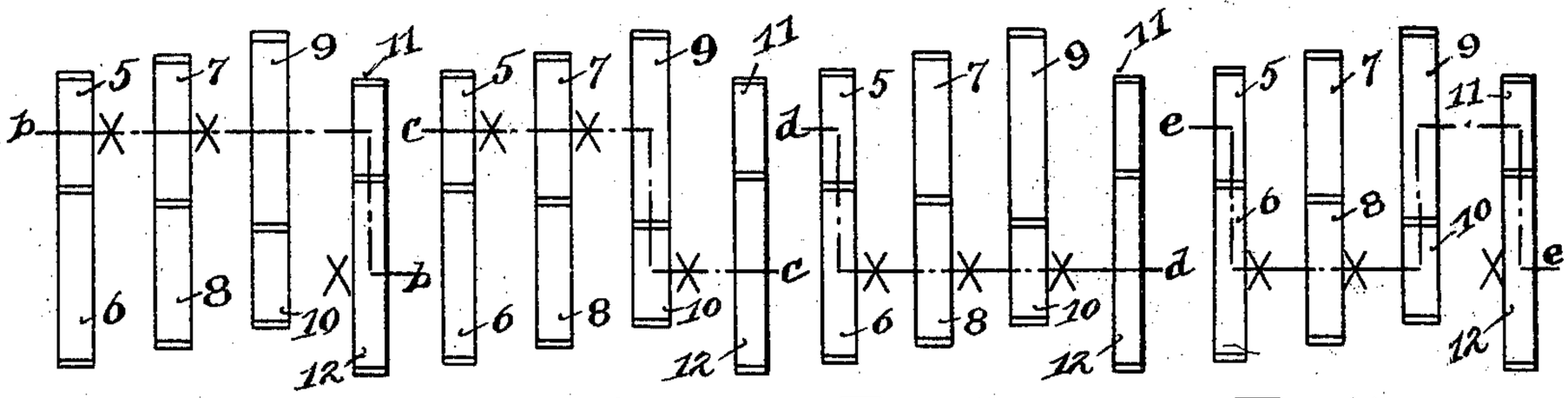

Fig. 4. Fig. 5. Fig. 6. Fig. 7.

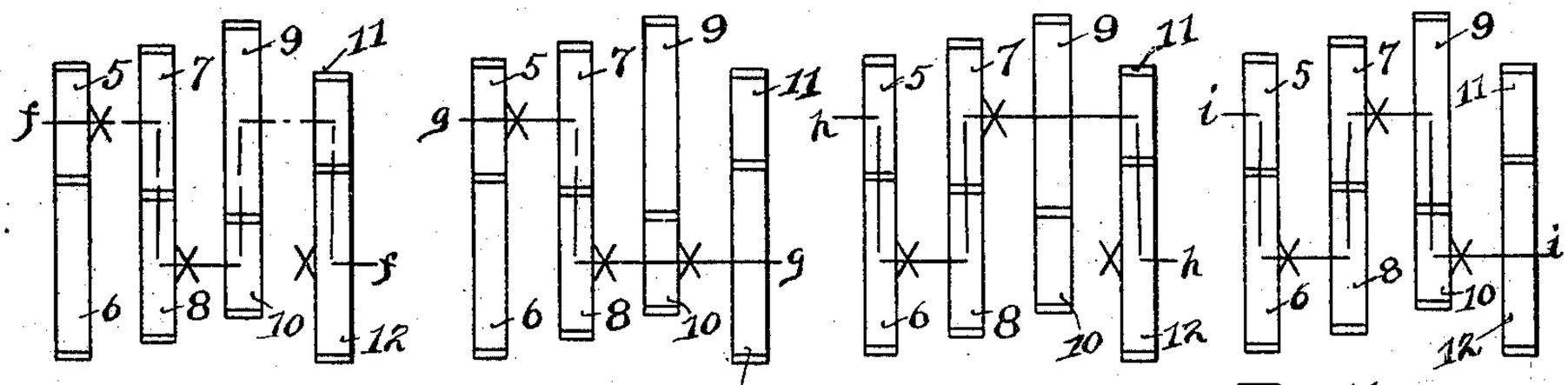

Fig. 8. Fig. 9. Fig. 10. Fig. 11.

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UNITED STATES PATENT OFFICE.

CHARLES F. LAUR, OF CINCINNATI, OHIO, AND ALBERT E. ROBINSON, OF COVINGTON, KENTUCKY, ASSIGNORS TO THE AMERICAN TOOL WORKS COMPANY, OF CINCINNATI, OHIO, A CORPORATION.

VARIABLE-SPEED MECHANISM.

SPECIFICATION forming part of Letters Patent No. 755,504, dated March 22, 1904.

Application filed October 19, 1903. Serial No. 177,536. (No model.)

To all whom it may concern:

Be it known that we, CHARLES F. LAUR, residing at Cincinnati, in the county of Hamilton, State of Ohio, and ALBERT E. ROBINSON, residing at Covington, in the county of Kenton, State of Kentucky, citizens of the United States, have invented certain new and useful Improvements in Variable-Speed Mechanism, of which the following is a specification.

The prime object of this invention is to produce changes of speed with a minimum number of gear-wheels.

The accompanying drawings show the improvement as an individual drive; but the prime object is to incorporate it into a machine-tool organization either as a variable-speed counter-shaft or it may be built directly into the machine-frame—as, for instance, into the head-stock of a lathe. The most acceptable method, however, for some classes of tools is to drive from a counter-shaft to the upper shaft on the variator and couple the driven shaft or lower one to the first work-shaft of the machine.

The improvement is not limited in its application to supplant the cone-pulley; but it may be used as a speed-varying device for feeds as well or as a compounder for other speed-varying devices—as, for instance, in the lathe where a cone of gears is employed to get the various pitches of threads it may be used in connection with the cone of gears to multiply the number of threads.

The features of the invention are more fully set forth in the description of the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a central vertical section of our invention. Fig. 2 is a section on line *x x*, Fig. 1. Fig. 3 is a central vertical section of a modified form. Figs. 4, 5, 6, 7, 8, 9, 10, 11 are diagram views illustrating the operation of the device of Fig. 3.

Following is the description of Fig. 3: the driving and driven shafts are 1 and 2, respectively. 5 5^a represent a gear-wheel and sleeve loose on shaft 1; 7 7^a, another gear-wheel and sleeve loose on shaft 1; 9 9^a, a third gear-wheel and sleeve fixed on shaft 1, and 11 a gear-wheel fixed on shaft 1. 3 is a driving-wheel fixed on the sleeve 5^a. 6 6^a represent a gear-wheel and sleeve loose on shaft 2. 8 8^a represent a gear-wheel and sleeve also loose on shaft 2. 10 10^a represent the third gear-wheel and sleeve loose on shaft 2, and 12 12^a represent a fourth gear-wheel and sleeve loose on shaft 2. The gear-wheels 5 and 6 are intermeshed, 7 and 8 are intermeshed, 9 and 10 are intermeshed, 11 and 12 are intermeshed. The left ends of the sleeve 7^a 9^a 8^a 10^a abut the right-hand faces of the gear-wheels 5 7 8 10, respectively. The sleeves 7^a 9^a 8^a 10^a are splined and upon them are slidably mounted the clutch members 13, 15, 17, and 19, respectively. The right-hand faces of the gear-wheels 5, 7, 6, and 8 are provided with the clutch members 14, 16, 18, and 20, which coöperate, respectively, with the sliding members 13, 15, 17, and 19. 21 represents a two-face clutch fixed to turn with shaft 2 and slidable thereon in either direction. The opposing face of the gear-wheel 10 is provided with a clutch member 22, by means of which said gear-wheel is fixed to shaft 2 when the clutch 21 is shifted to the left to make engagement with clutch member 22. The opposing face of the gear-wheel 12 is provided with a clutch member 23, by means of which said gear-wheel is fixed to turn with shaft 2 when the clutch 21 is shifted to the right into engagement with clutch member 23. 25 is a shifting-arm intermediately fulcrumed on shaft 26. One end of the arm 25 is connected to the sliding clutch member 13. The lower end of said arm is connected to the clutch member 17. 27 represents another shifting-arm intermediately fulcrumed on a shaft 28, the upper end of the arm 27 being connected to the sliding clutch member 15, the lower end of said arm being connected to the sliding clutch member 19. 29 represents a third shifting-arm, one end of which is fulcrumed on the shaft 30, the other end being connected to the double clutch 21. Each of these shifting-arms is provided with convenient means for controlling the same.

In the preferred form shown in Fig. 2 the

shaft 26 extends transversely of the supporting-cases and has the twin shifting-arms 25 25[a], the extremities of said arms being provided with the four pins and yokes 32 for engaging upon opposite sides of the sliding clutches 13 and 17 on shafts 1 and 2, respectively. A handle 31 is fixed to the shaft 26 at the outside of the casing for rocking the shifting-arm.

In Fig. 1, 4 is shown as a coupling for taking power from shaft 2.

It will be understood that Fig. 1 is practically the same as Fig. 3, except that the gear-wheels 5 and 6 and their sleeves, clutches, and shifting-arms are omitted, the pulley 3 being secured to the sleeve 7[a] of the gear 7.

Six gear-wheels giving four speeds are illustrated in Fig. 1 and eight gear-wheels giving eight speeds in Fig. 3.

As the clutch member 13 is connected to the clutch member 17 by the shifting-arm 25 and as the clutch 15 is connected to the clutch member 19 by the shifting-arm 27, it follows that clutch members 13 and 17 cannot be engaged at the same time and that clutch members 15 and 19 cannot be engaged at the same time. Also, obviously, operating-clutch members 22 23, respectively, and gear-wheels 10 12 cannot be fixed to shaft 2 at the same time.

Following is the operation of the arrangement of Fig. 1: If the clutch members 16 and 15 be engaged and the clutch member 21 be shifted into engagement with the clutch member 23, it follows that gear-wheel 9 will be clutched to the driving-wheel 3 and shaft 2 will be driven from the engagement with gear-wheels 11 12. If now the double clutch 21 be shifted to the left, disengaging members 21 23 and engaging members 21 22, obviously shaft 2 will be driven through the intermesh of gear-wheels 9 and 10, remaining gear-wheels being idle. If now the clutch member 19 be engaged with the clutch member 20, clutch members 16 15 will be disengaged through the shifting-arm 27 and shaft 2 will be driven through the intermesh of gear-wheels 7 and 8, remaining gear-wheels being idle. The parts remaining as last described, if the clutch members 21 and 22 be disengaged and clutch members 21 and 23 engaged the motion will be transmitted through the gear-wheels 7, 8, 10, 9, 11, and 12 in the order named. Thus four speeds are obtained from the six gear-wheels of Fig. 1 and the manipulation of two levers—*i. e.*, the levers controlling the shifting-arms 27 and 29.

Following is the description of the manipulation of the device of Fig. 3: Fig. 4 shows in diagram clutch members 13 and 14 engaged, 15 and 16 and 21 22, the relative speed of the two shafts depending upon the ratio of gearing of gear-wheels 11 and 12. This line of transmission is indicated by the dotted lines *b b*. Fig. 5 shows the double clutch on shaft 2 shifted to disengage the members 23 24 and to engage the members 21 22, the shafts being driven at a relative speed dependent upon the ratio of the gear-wheels 9 10. The line of transmission is shown by the dotted lines *c c*. In Fig. 6 arms 25 and 27 have been shifted to disengage the clutch members 13 and 14 and 15 and 16, thereby engaging clutch members 17 18 and 19 20 on shaft 2, clutch member 21 remaining in engagement with clutch member 22. The shafts are driven at a relative speed dependent upon the ratio of gear-wheels 5 and 6. The line of transmission is indicated by the dotted lines *d d*. In Fig. 7 clutch members 17 18 and 19 20 remain engaged and the double clutch is shifted to disengage the members 21 22 and to engage members 23 24. The shafts are driven at relative speeds dependent upon the ratio of the train of gears 5 6 10 9 11 12. The line of transmission is indicated by the dotted lines *e e*. In Fig. 8 clutch members 13 14 are engaged, also members 19 20 and members 23 24. The shafts are driven at a relative speed dependent upon the ratio of the gear-wheels 7 8 10 9 11 12. The line of transmission is indicated by the dotted lines *f f*. In Fig. 9 clutch members 13 14 are engaged, also 19 20 and 21 22. The shafts are driven at a relative speed dependent upon the ratio of the gear-wheels 7 and 8, the line of transmission being indicated by dotted lines *g g*. In Fig. 10 clutch members 17 18 are engaged, also members 15 16 and 23 24. The shafts are driven at relative speeds dependent upon the ratio of the train of gearing 5 6 8 7 11 12 the line of transmission being indicated by the dotted lines *h h*. In Fig. 11 clutch members 17 18 are engaged, also members 15 16 and members 21 22. The shafts are driven at relative speeds dependent upon the ratio of the gearing 5 6 8 7 9 10, the line of transmission being indicated by the dotted lines *i i*. Thus eight changes of speed are obtainable from the four pairs of intermeshing gear-wheels illustrated in Fig. 3.

Various well-known mechanical devices may be employed for fixing two or more gear-wheels together, so as to revolve as a unit on a given shaft, and also various mechanical means may be employed for fixing certain of the gear-wheels to their respective shafts. Also various methods may be employed for variously shifting to selected positions these devices by which the gear-wheels are fixed to one another on the same shaft or fixed to their shafts.

It is obvious that the driving relationship of the two shafts could be reversed—that is, 4 be the driving and 3 the driven wheel—without altering the principle. It is also obvious that the ratio of the gearing may be selected at will with a view to the requirements. Also it is obvious that in this system the unit is three pairs of intermeshing gear-wheels as a minimum adapted to give four changes of speed at least. Of these six gear-wheels two

are loose on their shafts, two are fixed, and two are loose but fixable to a shaft. Means are provided for fixing either of the fixable gears to its shaft, and means are provided for clutching the loose gear-wheel on each shaft to one of the other fixed or fixable gears on its shaft, so that two gears will revolve as a unit on the selected shaft.

As either of the two loose gear-wheels may be clutched to revolve with another gear-wheel on the same shaft and as two of the remaining fixable gear-wheels may be selectively fixed to a shaft, obviously the compounding of two speed-variators each having two changes gives a resultant of four minimum changes. The device shown in Fig. 3, where four pairs of intermeshing gears are shown, still contains this unit of three pairs of gear-wheels and get four changes plus. So, however the range be amplified, it will be built upon this system, and therefore respond to the more generic of the claims defining the invention.

Having described our invention, we claim—

1. In a variable-speed device, two shafts, three or more pairs of intermeshing gear-wheels of varying diameter, some of which are loose, some of which are fixed, and some of which are loose but fixable to a shaft, means for connecting together two or more of the gear-wheels on the same shaft, means for engaging a fixable gear-wheel with its shaft and a drive, substantially as specified.

2. In a variable-speed device, two shafts, pairs of intermeshing gear-wheels of varying diameter, loose on said shafts, means for connecting together gear-wheels on the same shaft, means for fixing some of the gear-wheels to the shaft, and means for rotating the prime member of the system, substantially as specified.

3. A variable-speed device, two shafts, intermeshing pairs of gear-wheels of varying diameter thereon, some of said gear-wheels being loose, some fixed, and some loose but fixable on said shafts, one intermeshing pair of the loose gears, having sleeves abutting the opposing faces of another pair of loose gears, sliding clutches on said sleeves, adapted to fix together two gear-wheels on the same shaft, means for rotating one of the loose gear-wheels, and means for fixing a fixable gear-wheel to its shaft, substantially as specified.

4. In a variable-speed device, two shafts, pairs of intermeshing gear-wheels of varying diameter thereon, some loose, some fixed, and some loose but fixable thereon, clutches between the gears adapted to lock a loose gear to a fixed gear, a clutch between one of the fixable gears and its shaft, a shifting-arm between the loose-gear clutches adapted to alternately engage and disengage them and means for rotating one of the members, substantially as specified.

5. In a variable-speed device, two shafts, three pairs of intermeshing gear-wheels of varying diameter thereon, some loose, some fixed and some loose but fixable, clutches and shifting means therefor substantially as shown for giving a minimum of four speed changes, and means for rotating one of the members, substantially as specified.

6. In a variable-speed device, two shafts, three pairs of intermeshing gear-wheels thereon, two of the gears being loose, two being fixed, and two loose but fixable means for clutching a loose gear to another gear on the same shaft, means for fixing either of the fixable gears to a shaft, and means for rotating one of the members, substantially as specified.

7. In a variable-speed device, two shafts, four pairs of intermeshing gear-wheels of varying diameter thereon, clutching, fixing and shifting means, for producing eight changes of speed, substantially as specified.

8. A variable-speed device comprising two shafts a minimum of three pairs of intermeshing gears thereon of varying diameter, one of the intermeshing pairs being loose on its respective shafts, a driving-wheel, two of the remaining gear-wheels being fixed, and two loose but fixable to the shaft, clutches between the pair of loose gear-wheels and the next adjacent pair of gear-wheels, adapted to fix two gear-wheels together to revolve as a unit on each shaft, and means for fixing either of the fixable gear-wheels to a shaft, substantially as specified.

9. In a variable-speed device, two shafts, a minimum of three pairs of intermeshing gear-wheels of varying diameter thereon, one pair of which is loose on said shaft, two of the remaining four gear-wheels being fixed and two loose but fixable on said shafts, clutches between the first and second pairs of gear-wheels adapted to fix two gear-wheels together to revolve as a unit on said shafts respectively, a shifting-arm engaging said clutches and adapted to alternately engage and disengage the clutches on opposite shafts, a shifting-clutch between the second and third pairs of intermeshing gear-wheels adapted to fix either of the two fixable gear-wheels to its shaft, and a driving-wheel, substantially as specified.

10. In a variable-speed device, two shafts, a minimum of three pairs of intermeshing gear-wheels of varying diameter thereon, one pair of which is loose thereon, two of the remaining four gear-wheels being fixed, and two loose but fixable to said shafts, shifting-clutches on said shafts between the loose and the next adjacent pairs of intermeshing gear-wheels, adapted to fix two gear-wheels together to revolve as a unit on each shaft, a transverse shaft between said first-named shafts, an arm thereon engaging said clutches for alternately shifting them, a handle for op-

erating said transverse shaft, a clutch between the fixed and the fixable gears adapted to fix either of the latter to its shaft, means for throwing said last-named clutch, and a drive, substantially as specified.

11. In a variable-speed device, two shafts, a minimum of three pairs of intermeshing gear-wheels of varying diameter thereon, one intermeshing pair being loose, two of the remaining gears being fixed and two loose but fixable to said shafts, clutches between the loose pair and the next adjacent pair, a clutch between said fixed and fixable gears, means for shifting said clutches to give a minimum of four speeds, and a drive, substantially as specified.

12. A speed-variator comprising two shafts, a set of six gears of varying ratios arranged in series on the two shafts, clutch-and-lever mechanism on both shafts by suitable manipulation of which four changes of speed may be obtained, substantially as specified.

13. A speed-variator comprising a frame, two shafts parallel to each other, a loose gear-wheel on either shaft carrying at one end of its hub the means for receiving power from some outside source and clutch-and-lever mechanism for connecting said loose gear-wheel in train with the other gears, substantially as specified.

14. A speed-variator comprising a frame, two parallel shafts, six gears mounted on the two parallel shafts, said gears being disposed oppositely in pairs in the same plane, clutch-and-lever mechanism on both shafts, a pair of rock-shafts, rocker-arms and clutch-forks carried by said rock-shafts, and a pair of levers for the purpose of shifting the clutches, substantially as specified.

15. In a speed-variator, a frame, two shafts, a pair of intermeshing gear-wheels loosely mounted on said shafts, a power-wheel fixed to one of said gear-wheels, a second pair of intermeshing gear-wheels on said shafts, having elongated hubs, extended toward said first-named pair of gear-wheels, the said second pair of gear-wheels being also loosely mounted on their shafts, clutches splined on the said hubs and adapted to engage the first-named gear-wheels, whereby two gear-wheels on the same shaft may be fixed to rotate as a unit, means for shifting said clutches, and means for fixing a loose gear-wheel to its shaft, substantially as described.

16. In a variable-speed device, two shafts, a loose and a fast gear on one shaft, loose gears on the other shaft, means for fixing said gears in proper driving relation, and a power-wheel mounted to rotate with the loose gear for imparting or receiving motion, substantially as specified.

17. In a variable-speed device, two shafts, pairs of intermeshing gears of varying diameter, loose thereon, means for fixing two gears together on their shaft, and means for fixing a selected gear to its shaft, substantially as specified.

In testimony whereof we have hereunto set our hands.

CHARLES F. LAUR.
ALBERT E. ROBINSON.

Witnesses:
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