No. 624,017. Patented May 2, 1899.

F. G. HAMPSON.

CHANGE DRIVING GEAR.

(Application filed Oct. 31, 1898.)

(No Model.) 6 Sheets—Sheet I.

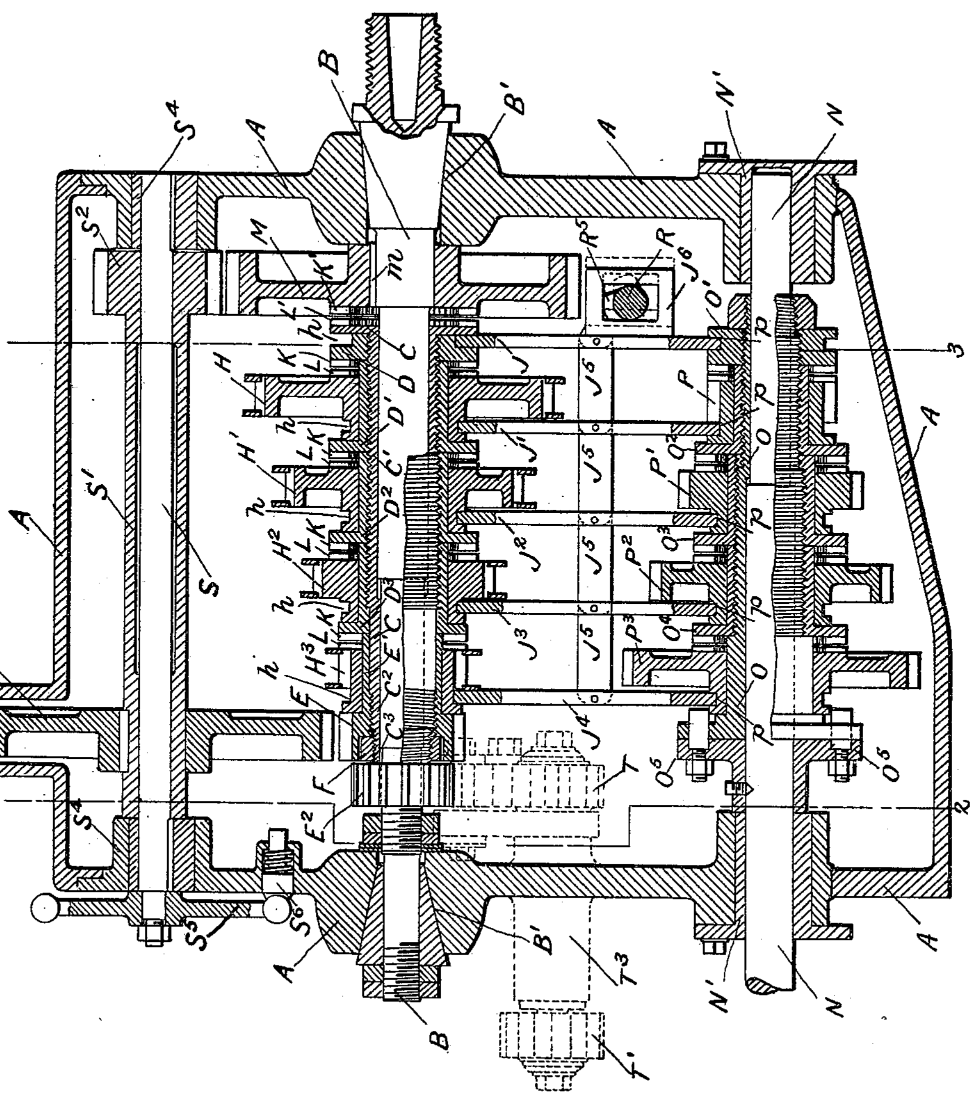

FIG. 1.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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(No Model.) 5 Sheets—Sheet 2.

FIG. 3.

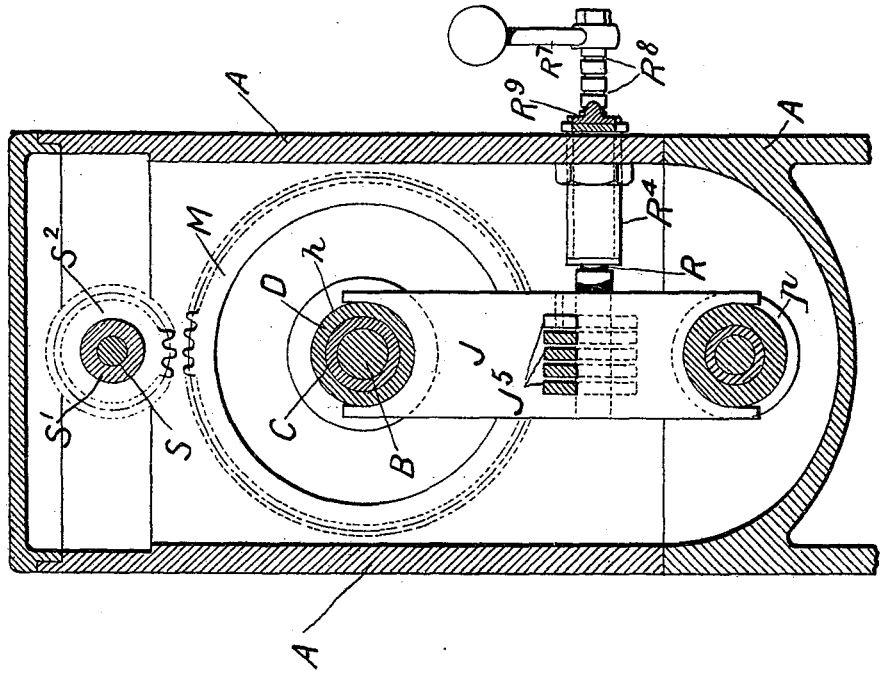
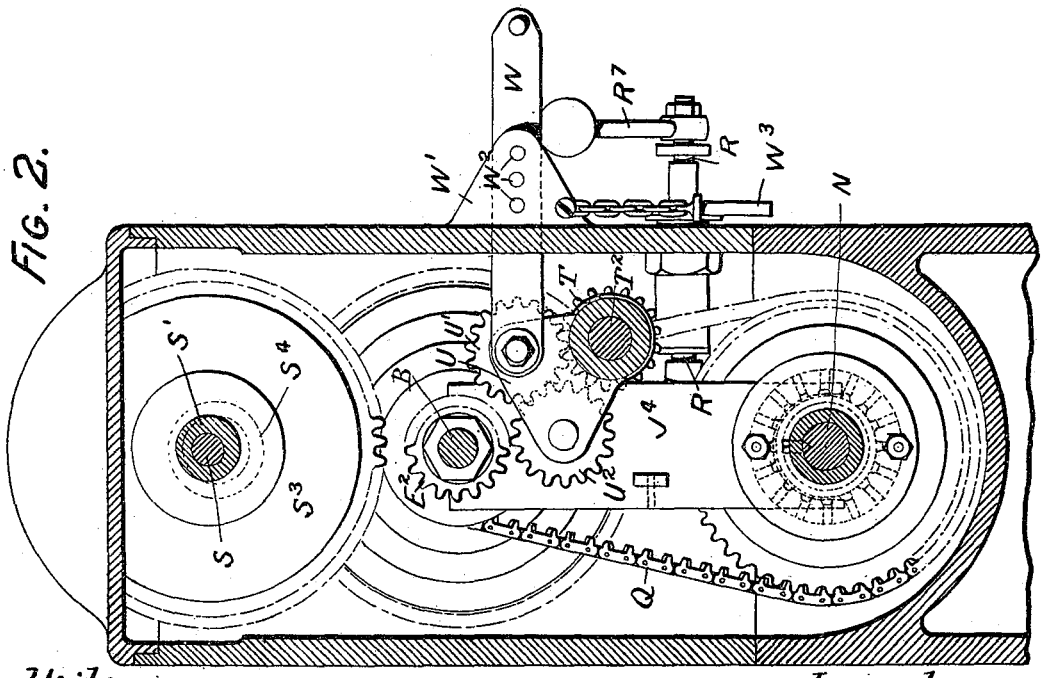


FIG. 2.



Witnesses

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(No Model.) 6 Sheets—Sheet 3.

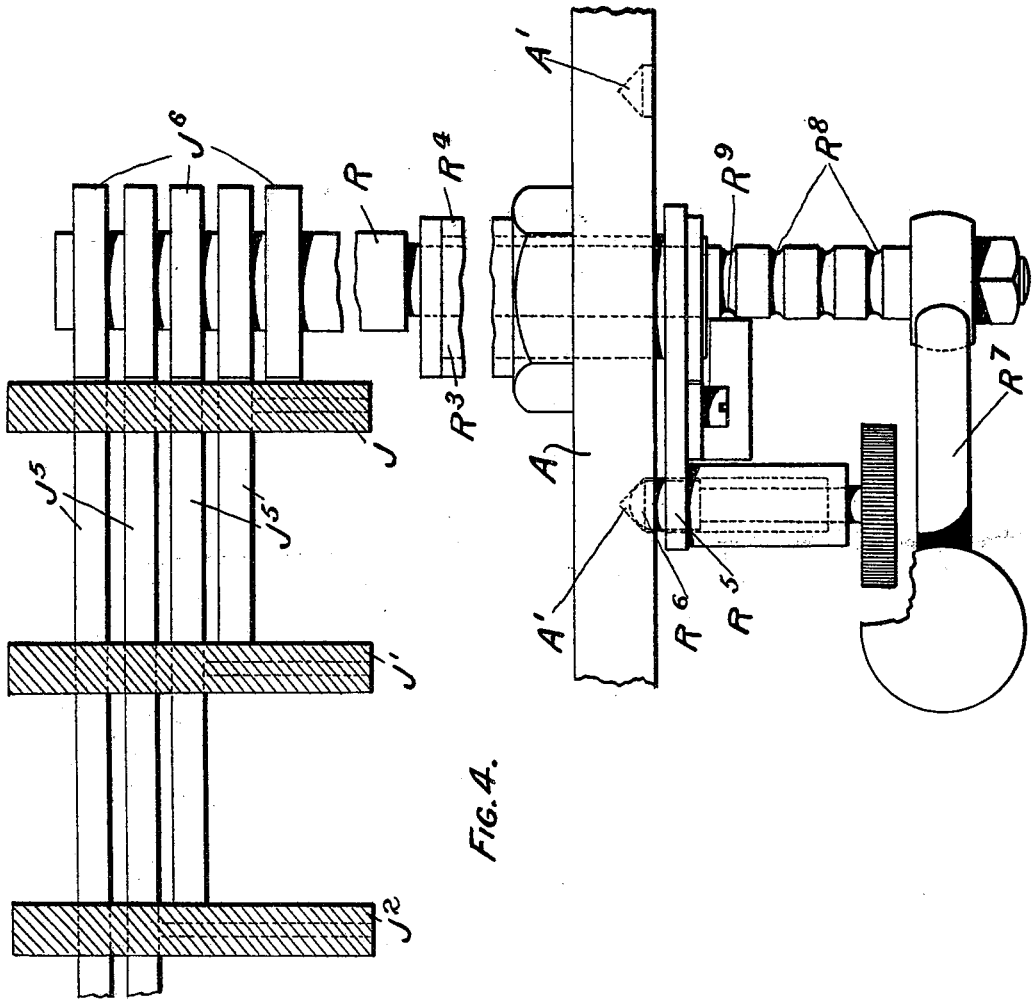

FIG. 4.

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(No Model.) 6 Sheets—Sheet 4.

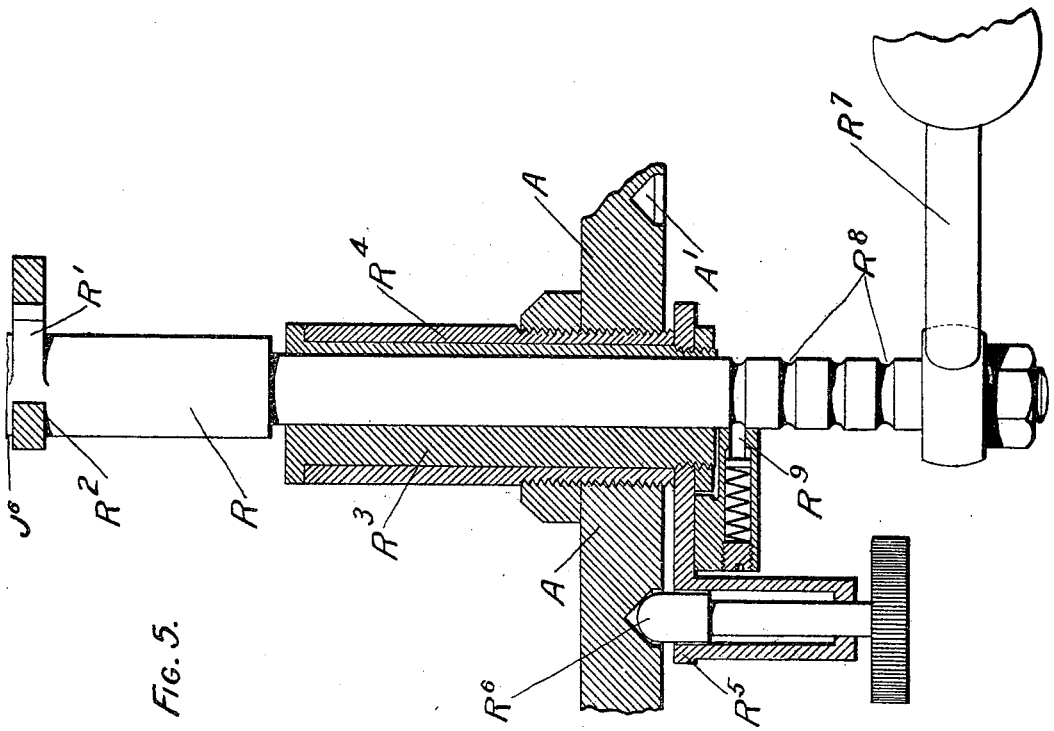

FIG. 5.

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CHANGE DRIVING GEAR.

(Application filed Oct. 31, 1898.)

(No Model.) 6 Sheets—Sheet 5.

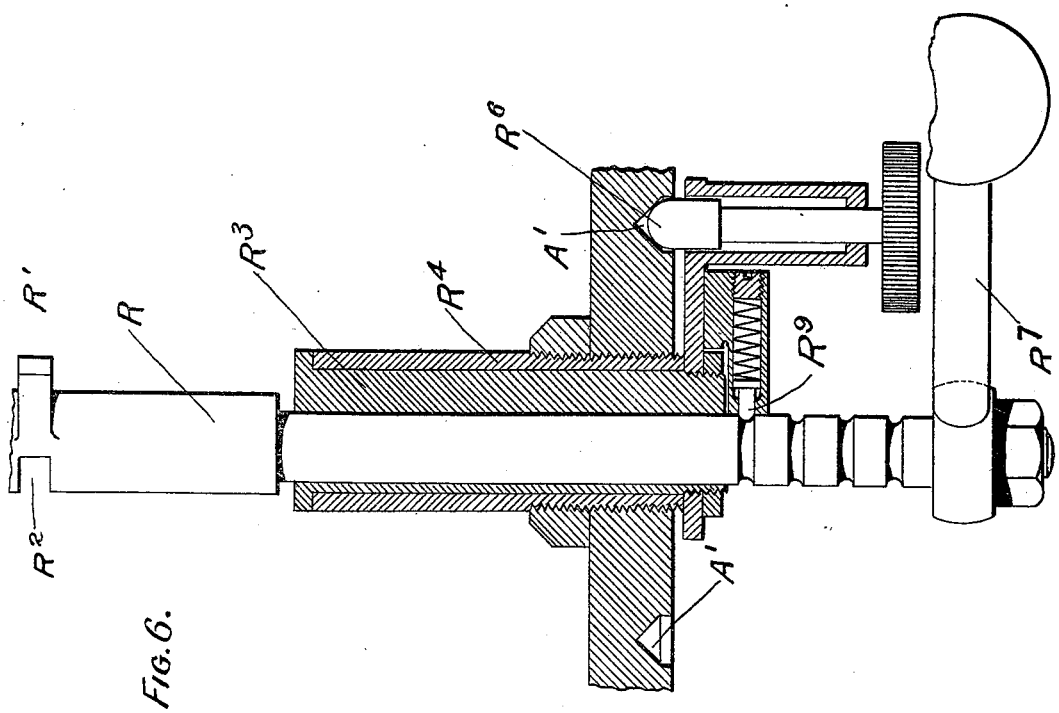

FIG. 6.

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CHANGE DRIVING GEAR.

(Application filed Oct. 31, 1898.)

(No Model.) 6 Sheets—Sheet 6.

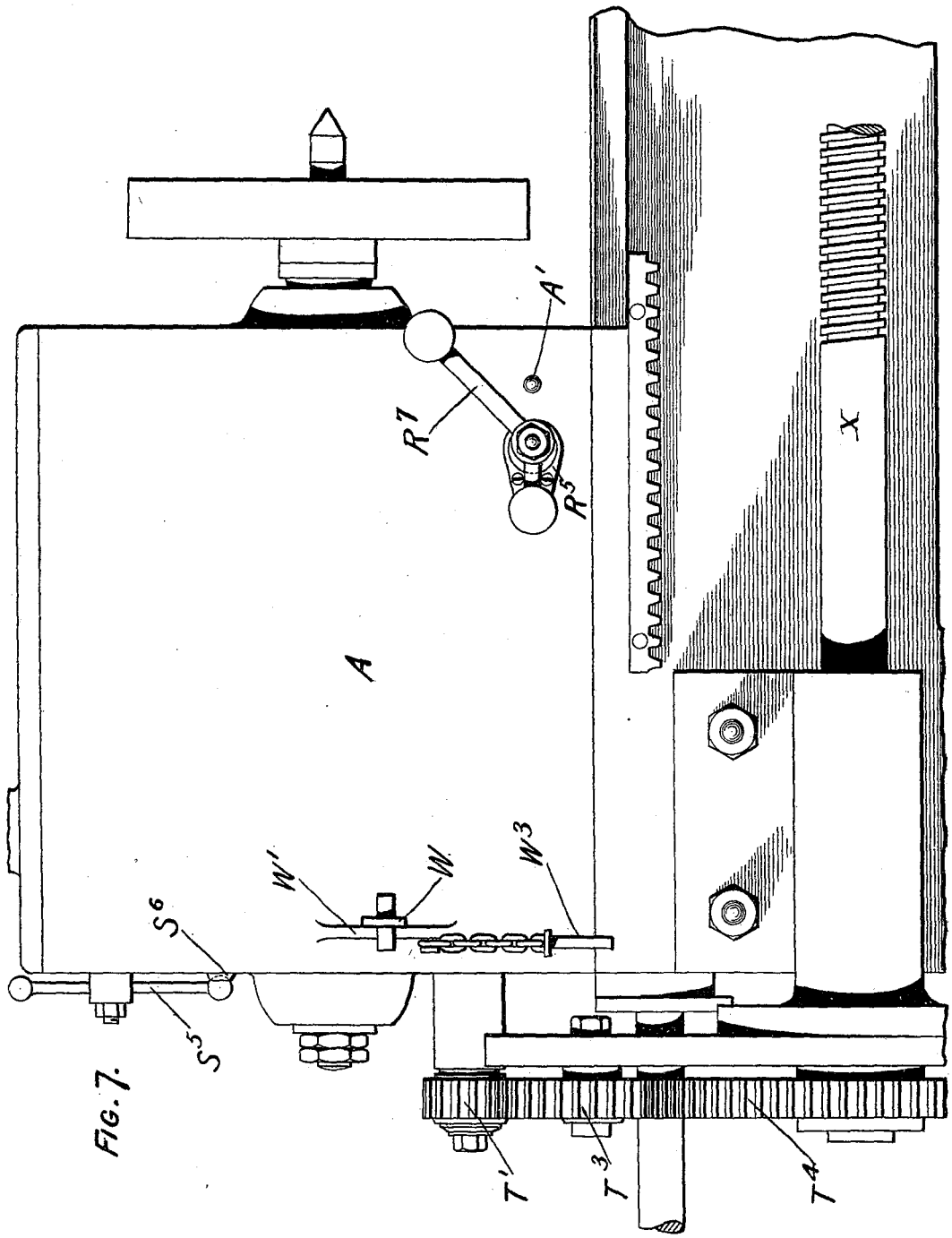

FIG. 7.

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UNITED STATES PATENT OFFICE.

FRANK GEORGE HAMPSON, OF SHOREHAM, ENGLAND.

CHANGE DRIVING-GEAR.

SPECIFICATION forming part of Letters Patent No. 624,017, dated May 2, 1899.

Application filed October 31, 1898. Serial No. 695,048. (No model.)

To all whom it may concern:

Be it known that I, FRANK GEORGE HAMPSON, a subject of the Queen of England, residing at Shoreham, England, have invented certain new and useful Improvements in Change Driving-Gear, (for which I have made application in Great Britain under No. 7,831, dated April 1, 1898,) of which the following is a specification.

This invention relates to change driving-gear and is applicable to various kinds of machine-tools and to other forms of driving, including self-propelled vehicles. In fact, the gear is applicable in nearly all cases where change driving-gear is required. I will at present describe it as applied to a lathe.

In applying this invention to a lathe I employ a spindle and head-stock of substantially usual construction, and upon the spindle I place a sleeve which carries in any convenient manner the appropriate number of driving-gears or equivalent, each loose upon the sleeve, but capable of being coupled to the sleeve. The sleeve can also be coupled to the spindle. Any suitable form of clutch or other mechanism for engaging and disengaging the various parts may be employed, but the following mechanism is suitable for the purpose: Each gear or equivalent is provided with a number of teeth or projections which engage when desired with similar teeth upon a portion of the sleeve, the two sets of teeth forming a clutch. A similar clutch may be used for effecting the engagement of the sleeve with the spindle. In or in connection with the head-stock I provide a counter-shaft having a series of gears or equivalents corresponding to the gears upon the spindle, but reversed in position in the well-known manner. These gears may be mounted upon the counter-shaft in a similar manner to that in which the gears are mounted upon the spindle, and the two series of gears are operatively connected in pairs in any suitable manner, but preferably by chains, as the shafts may be very near together and the gears small. Each pair of gears is preferably controlled by a clutch-rod, so that it may be thrown in or out of gear with the sleeve, as desired, and a similar rod is provided to operate the clutch between the sleeve and the spindle. The clutch-rods are operated by a shaft which is so arranged that any particular clutch-rod may be operated, as desired, and whatever disposition of the driving mechanism may have been made it will not be disturbed by engaging the sleeve and spindle. The counter-shaft may be driven by means of a belt or chain pulley, which may either be rigidly secured upon it or may be connected by a friction or other clutch, so as to be thrown entirely out of gear, no loose pulley being necessary. Preferably I drive this gear by belt or chain mechanism from below instead of from above, and where a number of tools are arranged in the same line a single shaft may run underneath the whole of them and may thus drive them, or this may be the previously-described counter-shaft. This primary shaft, whether it be the counter-shaft or not, may be driven from a main shaft or a main pulley or equivalent underneath the floor, or where overhead shafting already exists and must therefore be used the first motion will be received by this main driving belt or chain.

Wherever possible, I prefer to so box in the mechanism that where chain-driving is employed it may always run in an oil-bath, or an oil-bath may be formed in the frame or bed of the machine-tool or other device to which the gear is applied. Where such an arrangement is applicable, the counter or primary shaft may be made adjustable to accommodate the stretch or wear of the chains, and it may, if necessary, be formed in separate lengths for this purpose, the various lengths being connected by some suitable form of universal joint or coupling. Other means may be employed for tightening the chains, such as an idle or jockey pulley, which may operate automatically by spring or weight, and in some cases the driving and driven shafts may be upon the same level, so that the chain lying approximately horizontal, or nearly so, with the sag of the chain may keep the "driving-run" sufficiently tight.

In the accompanying drawings, which illustrate one construction of change speed-gear according to this invention applied to a lathe, Figure 1 is longitudinal vertical section through the head-stock, the chains being omitted for clearness. Figs. 2 and 3 are sec-

tions on the lines 2 2 and 3 3, respectively, of Fig. 1. Figs. 4, 5, and 6 show in plan on a larger scale details of a portion of the gear in several positions, and Fig. 7 is a side elevation showing the head-stock in position upon a portion of the bed of a screw-cutting lathe.

Like letters indicate like parts throughout the drawings.

A is a frame or casing serving to support and partly inclose the various parts which constitute the head-stock.

B is a spindle forming the usual mandrel of the lathe. It is supported in coned bearings B′ in the case A. Upon the mandrel B and free to rotate and slide upon it is a sleeve C, screwed as at C′ C^2 C^3. Four flanged sleeves D D′ D^2 D^3 are screwed upon the portion C′ of the sleeve C, and a spur-wheel E, having an extension in the form of a sleeve E′, is screwed upon the portion C^2. A lock-nut F upon the screwed part C^3 of the sleeve C serves to prevent the spur-wheel E from becoming unscrewed. The thread in the spur-wheel E is left-handed. A gear-wheel E^2 is also provided, mounted directly upon the mandrel B. Four chain wheels or gears H, H′, H^2, and H^3 are mounted free to rotate and to move longitudinally upon the sleeves D′, D^2, D^3, and E′, respectively, and the boss of each of these gears H, H′, H^2, and H^3 is furnished with a recess, as at *h*, to accommodate one of a series of clutch-levers J′, J^2, J^3, and J^4. A similar recess is formed upon the sleeve D to receive a clutch-lever J.

Upon the left-hand side of each of the sleeves D, D′, D^2, and D^3 a series of projections or teeth K is provided, and upon the right-hand sides of the gears H, H′, H^2, and H^3 are similar projections L. The adjacent sets of projections L K form clutches, by means of which any one of the gears H H′ H^2 H^3 may be engaged with its corresponding sleeve, and consequently to the main sleeve C.

In order that when desired the sleeve C may be operatively connected with the mandrel B, it is provided with a set of projections L′, which coöperate with a corresponding set K′ to form a clutch similar to the clutches L K. The projections K′ are formed upon the side of a toothed wheel M, which forms one of the wheels of the back gear and is keyed, as at *m*, to the mandrel B.

N is a counter-shaft supported in oil-tight eccentric bearings N′ in the case A. It is provided with a sleeve O, carrying a series of sleeves O′, O^2, O^3, and O^4 and chain-wheels or gears P, P′, P^2, and P^3, which are arranged with clutches in a manner substantially the same as described with reference to the mandrel B. The sleeve O is capable of longitudinal motion upon the shaft N, but always rotates with it through the action of a coupling O^5. The bosses of the chain-wheels P P′ P^2 P^3 are recessed, as at *p*, to accommodate the other ends of the clutch-levers J′ J^2 J^3 J^4, and the sleeve O′ has a similar recess to receive the clutch-lever J.

The counter-shaft N is driven in any desired manner from the source of power.

Each of the gears upon the counter-shaft N is opposite to one of the gears upon the mandrel B and is geared to it by a driving-chain, as at Q, Fig. 2. The recesses *h* and *p* in the bosses of each pair of gears receive opposite ends of one of the clutch-rods J′, J^2, J^3, or J^4, and the sleeves C and O are connected in a similar manner by means of the rod J, the ends of which enter the recesses *h* and *p* in the screwed sleeves D and O′, respectively.

Each of the clutch-rods J J′ J^2 J^3 J^4 is provided with an arm J^5, which terminates in a box or frame J^6. Each arm J^5 is connected only to its own particular clutch-lever and passes freely through slots or openings in the others—*e. g.*, the arm J^5, which is connected to the clutch-rod J^2, Fig. 4, passes freely through the clutch-rods J and J′.

Through the interior of the frames J^6 a shaft R passes, having a projection or cam R′ upon it. A recess R^2 is formed in the shaft R opposite to the cam R′.

The shaft R is mounted eccentrically in a bush R^3, Figs. 5 and 6, which is carried in a bearing R^4 in the side wall of the case A. A handle R^5, with a spring-controlled stop R^6, is attached to the bush R^3, and two hollows A′ are formed in the case A to receive the stop R^6, so that by turning the handle R^5 the shaft R may be caused to move bodily in a lateral direction in the case A, and by means of the stop R^6 and the hollows A′ may be fixed in either of its extreme positions. The horizontal dimension of the interior of the frames J^6 is approximately equal to the diameter of the shaft R, so that the lateral movement of the shaft causes a corresponding movement of the arms J^5, which accordingly move their respective clutch-rods J J′ J^2 J^3 J^4. The effect of this is to cause the sleeve C to engage or disengage with the mandrel B by means of the clutch L′ K′ and to move the sleeve O longitudinally upon the counter-shaft N. This occurs, however, without altering the relative positions of the gears and clutches.

The shaft R is capable of longitudinal motion in the bush R^3. This is necessary in order to bring the cam R′ in line with any one of the frames J^6. A handle R^7 is provided in order that the shaft may be moved in the bush R^3, and grooves R^8 are turned in the shaft in such a position that when a spring-catch R^9 is in engagement with one of the grooves R^8 the cam R′ is inside one of the frames J^6. As illustrated in Fig. 4, the shaft R is withdrawn as far as possible and the cam is inside the frame J^6, which operates the clutch-rod J′. The cam R′ never enters the first frame J^6—*i. e.*, that one connected to the clutch-rod J—because that clutch-rod is never required to move by itself relatively to the other clutch-levers, and is therefore only operated by the lateral movement of the shaft R.

The bearings N′ of the counter-shaft N be-

ing made oil-tight, oil may be placed in the lower portion of the case A, so that the driving-chains Q are constantly lubricated.

The arrangement of back gear is as follows: A sleeve S′, Fig. 1, carries two gear-wheels S^2 and S^3, which engage with the gear-wheels M and E, respectively, in a manner similar to the usual arrangement of back gear. The sleeve S′ rotates upon a spindle S, which is carried in eccentrics S^4 in the case A, and is provided with a handle S^5 and a spring-socket S^6 in order that the gear-wheels S^2 and S^3 may be readily placed in or out of engagement with the wheels M and E and kept in the desired position.

Gear-wheels for screw-cutting are shown attached to the improved head-stock in Figs. 1, 2, and 7. Two gear-wheels T and T′ are mounted at opposite ends of a shaft T^2, carried in a bearing T^3 in the case A. A triangular plate U is pivoted around the shaft T^2 and carries two gear-wheels U′ and U^2. This plate U is controlled by a lever W, which slides in the case A, as at W′. By sliding the lever W in or out the plate U is turned upon the shaft T^2, so that (*a*) neither of the wheels U′ or U^2 engage with the wheel E^2; (*b*) the wheel U′ engages with the wheel E^2 and drives the wheel T in one direction, or (*c*) the wheel U^2 gears with the wheel E^2 and drives the wheel U′ and through it the wheel T in the other direction. The motion of the wheel T is transmitted through the shaft T^2 to the wheel T′, which by means of wheels T^3 and T^4 drives the leading-screw X. The lever W may be held in either of the three positions by means of the holes W^2 and the pin W^3.

The operation of the improved head-stock is as follows: Assuming the gear to be in the position illustrated in Fig. 1—*i. e.*, all the clutches are inoperative—if it is desired to drive the mandrel B without the use of the back gear the handle R^5 is turned until the eccentric bush R^3 has rotated in the bearing R^4 and carried the shaft R into the position shown in Figs. 4 and 5—*i. e.*, into its extreme right-hand position. This movement of the shaft R causes all the frames J^6 to move, and consequently all the clutch-rods J J′ J^2 J^3 J^4 move also and the sleeve C moves longitudinally upon the mandrel B and is geared with it through the clutch L′ K′. A corresponding longitudinal motion of the sleeve O takes place upon the counter-shaft N. No relative motion of the clutch-rods J J′ J^2 J^3 J^4 has, however, taken place, and therefore the clutches controlling the chain wheels or gears are still inoperative. If now the handle R be turned as in Fig. 5, the cam R′ moves the particular frame J^6 that it is within, and consequently the clutch-rod connected with that frame moves and one pair of chain wheels or gears is thrown into engagement. As illustrated in Fig. 5, the longitudinal position of the shaft R is such that the movement of the cam R′ would have caused the clutch-rod J′ to move and would therefore have thrown the chain wheels or gears H and P into operation. It should be observed that when the shaft R is rotated and the cam R′ operates upon one of the frames J^6 the left-hand portion of that frame enters the recess R^2 in the shaft R, Fig. 5, and thus the engagement of any other pair of chain wheels or gears with the sleeve is rendered impossible until the shaft R has been turned back and the clutch then in action disengaged.

When the back gear is employed, the operation is as described above, except that the shaft R is not moved laterally, but is kept in the position illustrated in Fig. 6, so that the sleeve C is not directly engaged with the mandrel B. The back gear-wheels S^2 and S^3 are placed in gear with the wheels M and E upon the sleeve C by turning the shaft S and its eccentrics S^4, and any desired pair of chain wheels or gears is thrown into operation as above described.

Any slackness due to wear or stretch in the driving-chains may be taken up by turning the eccentric-bearings N′, in which the counter-shaft N is carried.

It is obvious that various modifications may be made in change speed-gear according to this invention without departing from the spirit thereof. For instance, the chain wheels or gears H P, &c., may be in the form of pulleys or gear-wheels directly engaging with each other, and it is therefore to be understood that the term "gears" as used herein is intended to include all equivalent devices. It will readily be seen, too, that gear according to this invention is very suitable for use in conjunction with an electric motor, the motor driving the counter-shafts of one or more machine-tools, and thus dispensing with all overhead shafting, belts, &c. Modifications may also be made in the gear for controlling the sleeves C O and the pairs of related chain wheels or gears H P, H′ P′, H^2 P^2, and H^3 P^3. For instance, I may effect the simultaneous adjustment of the group of clutch-levers J J′ J^2 J^3 J^4 by a shaft R, movable laterally in a manner hereinbefore described, while I may cause the subsequent rotation of that shaft R to effect the engagement of the gears H and P, for instance, with their respective sleeves by clutches which need not depend for their action upon endwise movement of the gears. Further, it is practicable to dispense altogether with the clutch-lever J connecting the two sleeves, for with that lever absent any movement given to the remaining four clutch-levers J′ J^2 J^3 J^4 and tending to move the gears on the sleeve will instead have the effect of moving the gears and sleeves in company instead of in relation to each other, for the reason that it would be necessary for any relative movement of the gears and sleeves to take place that the four series of clutch-teeth K L should simultaneously have the teeth in each pair opposite the recesses between the opposing teeth, and the balance of chances is against the oc-

currence of such particular and precise juxtaposition. From the foregoing it will be seen that with the first clutch-lever J dispensed with the initial lateral movement of the shaft R must have the effect of moving the sleeve C endwise to engage it with the mandrel B. The individual clutch-plates J' J^2 J^3 J^4 can afterward be moved to engage individual gears H H' H^2 H^3 with that sleeve and to move the related gears of the series P as may be necessary.

It is not necessary that the cross connection between each pair of chain wheels or gears H P should take the form of clutch-rods, such as J. For instance, if the gears H and P were spur-wheels with shrouded teeth operatively connected by an intermediate pinion movement of the intermediate pinion in the line of its axis would move with it the toothed wheels H and P, because the teeth on the intermediate pinion would bear in such lateral movement upon the shroudings of the teeth of the wheels to which it is geared. In this instance the intermediate pinion constituted the cross connection.

I claim—

1. In change speed-gear, the combination of a driving-spindle, a driving-sleeve encircling it, driving-gears on that sleeve, a clutch to engage each gear therewith, a driven spindle, a driven sleeve encircling it, a clutch to engage and disengage that driven sleeve and spindle, driven gears on that driven sleeve and a clutch to engage each gear therewith, the driving and the driven gears being operatively connected, substantially as set forth.

2. In change speed-gear, the combination of a spindle, a sleeve encircling it, and a clutch to engage and disengage that sleeve and spindle, gears on that sleeve, and a clutch to engage each gear therewith, substantially as set forth.

3. In change speed-gear, the combination of a driving-spindle, driving-gears on that spindle, a clutch to engage each gear therewith, a driven spindle, driven gears on that driven spindle, and a clutch to engage each gear therewith, the driving and the driven gears being operatively connected, substantially as set forth.

4. In change speed-gear, the combination of a driving-spindle, a driving-sleeve encircling it and movable endwise, driving-gears on that sleeve, a clutch to engage each gear therewith, a driven spindle and driven sleeve encircling it and movable endwise, a clutch to engage and disengage that driven sleeve and spindle, driven gears on that driven sleeve and a clutch to engage each gear therewith, the driving and the driven gears being operatively connected, cross-pieces connecting the driving and driven sleeves and connecting in pairs the driving and driven gears, mechanism for moving all the cross-pieces simultaneously and also individually, substantially as set forth.

5. In change speed-gear, the combination of a driving-spindle, a driving-sleeve encircling it and movable endwise, driving-gears on that sleeve, a clutch to engage each gear therewith, a driven spindle and driven sleeve encircling it and movable endwise, a clutch to engage and disengage that driven sleeve and spindle, driven gears on that driven sleeve and a clutch to engage each gear therewith, the driving and the driven gears being operatively connected, cross-pieces connecting the driving and driven gears and mechanism for moving all the cross-pieces simultaneously and also individually, substantially as set forth.

6. In change speed-gear, the combination with cross-pieces operatively connecting the parts supported by the driving and driven shafts, of an eccentric bush, a spindle supported therein and provided with projections and clutches appropriated to the several related pairs of driving and driven gears, and with which clutches said projections individually are operatively connected, substantially as described.

7. In change speed-gear, the combination with cross-pieces operatively connecting the parts supported by the driving and driven shafts, of an eccentric bush, a spindle supported therein and provided with a projection having a recess opposite to it, and frames each fitting the spindle and each connected with an individual cross connection, substantially as and for the purpose set forth.

In witness whereof I have hereto set my hand in the presence of the two subscribing witnesses.

FRANK GEORGE HAMPSON.

Witnesses:

HARRY B. BRIDGER,

J. A. MORGAN.