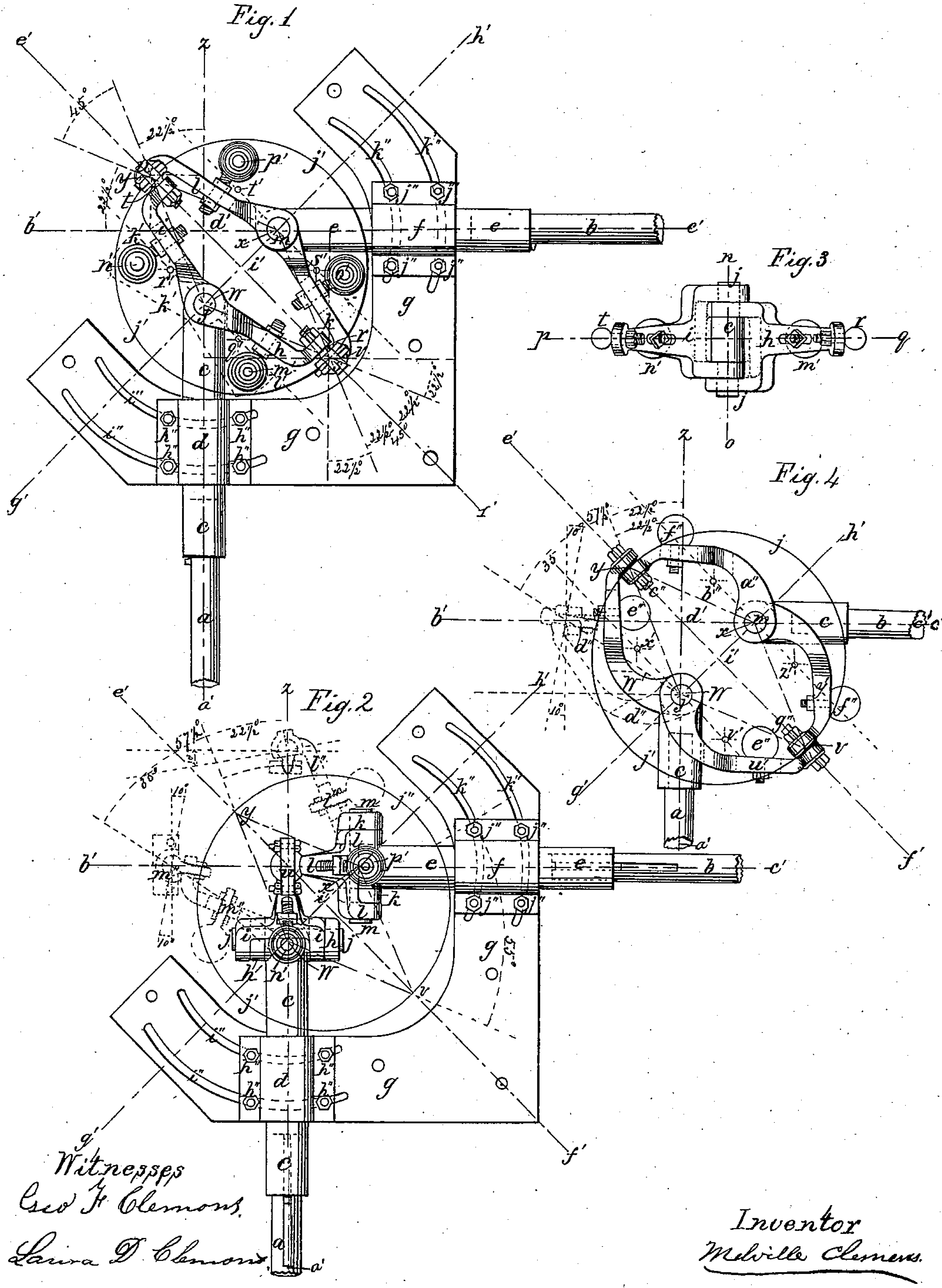
M. Clemens.

Transmitting Rotary Motion.

No. 96,395. Patented Nov. 2, 1869.



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Letters Patent No. 96,395, *dated November* 2, 1869.

IMPROVEMENT IN APPARATUS FOR TRANSMITTING ROTARY MOTION.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, MELVILLE CLEMENS, of Springfield, in the county of Hampden, in the State of Massachusetts, have invented a new and useful Device for Transmitting Rotary Motion and Power from one revolving shaft of machinery to another, which I denominate "The Pivoted Crank-Shaft Coupler;" and I do hereby declare that the following is a full and exact description of the construction and operation of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, making part of this specification.

Figure 1 is a side elevation of the said device, shown coupling together a vertical and a horizontal shaft.

Figure 2 is a similar side elevation of the same when the connected shafts are revolved on their axes one-fourth of a revolution from their position shown in fig. 1.

Figure 3 is an inside plan view of the pivoted crank-arms of the vertical shaft.

Figure 4 shows a mode of construction of the pivoted crank-arms, so that they shall counterbalance each other on their shafts.

The red-ink diagram lines on the figures are employed to illustrate mechanical features of construction and operation of the device.

Like letters refer to like parts in all the figures where they are employed.

The nature of my said invention consists, chiefly, in connecting any two revolving shafts together, for propelling machinery, by means of one or more pairs of crank-arms, which are attached, at their inner ends, to the connected ends of the shafts by a pivoted connection thereto, and which are pivoted together, at their outer ends, in such a manner, substantially as hereinafter set forth, as to enable, thereby, the transmission of equal and uniform rotary power and motion from one shaft to the other, whether the said shafts are set in line with each other, or set in lines diverging from each other.

Referring to the drawings for a description of the construction and operation of the said device—

a and *b* are two revolving shafts, for communicating motion to machinery, which are connected together by my said pivoted crank-shaft coupler, the shaft *a* being vertical, and the shaft *b* horizontal, so that the two diverge ninety degrees, or turn a right angle.

The inner end of the shaft *a* is secured concentrically to a hub *c*, which revolves in, and is supported by a journal-box, *d*, which is secured to a supporting-plate, *g*.

The shaft *b* is similarly secured to a hub, *e*, revolving in, and supported by a journal-box, *f*, which is secured to the plate *g*.

h and *i* are two pivoted crank-arms, of equal lengths, whose inner ends are forked, as shown in fig. 3, and pivoted on a pivot-pin, *j*, which is fixed, centrally, in the end of the hub *c*, and is at right angles to it.

k and *l* are two similar pivoted crank-arms, of equal lengths, pivoted to the hub *e* by the pivoted pin *m*, as *h* and *i* are pivoted to the hub *c*.

As shown in fig. 3, the centre line *n o*, of the pivot-pin *j*, is at right angles to the line *p q*, which is the centre line of the crank-arms *h* and *i*.

The two crank-arms, *h* and *i*, of the shaft *a*, are joined, at their outer ends, to the two crank-arms *k* and *l*, of the shaft *b*, by ball-and-socket joints, whose centres are, respectively, at the points of intersection of the centre lines of the crank-arms so joined together, the crank-arm *h* being connected, by its ball *r*, to the crank-arm *k*, by its socket-box *s*, and the crank-arm *i* being similarly connected, by its ball *t*, to the crank-arm *l*, by its socket-box *u*.

The ball-and-socket joints *r s* and *t u* are properly "crank-wrists," connecting the crank-arms together in pairs, by universal pivot connection, and they are the points at which motion and power are transmitted from the appendages of one shaft to the like appendages of the other shaft.

Each of the pair of crank-arms, *h* and *k*, is of exactly equal length, measured in a straight line, drawn from the centre point of their ball-and-socket joint, to the centre points of their inner-end pivot-pins; and similarly, each of the pair of crank-arms *i* and *l* must be of exactly equal length.

Thus, the line *v w* is the length of the crank-arm *h*, and the equal line *v x* is the length of the crank-arm *k*; and similarly, the line *y w* is the length of the crank-arm *i*, and the equal line *y x* is the length of the crank-arm *l*.

To aid in describing the principles of construction and operation of the device, reference will now be made to the red-ink diagram lines on the figures.

z a' is the axis-line of the shaft *a*;

b' c' is the line of the shaft *b*; and

d' is the point of their intersection.

e' f' is a line, bisecting the angle of intersection of the axis-lines *z a'* and *b' c'*, and it is at an angle of forty-five degrees to each of them.

The centre points, *w* and *x*, of the pivot-pins *j* and *m*, are at equal distances from the intersection point *d'*.

The line *g' h'*, passing through the pivot-points *w* and *x*, is at right angles to the line *e' f'*, and *i'* is their point of intersection.

The line *v w* (representing the crank-arm *h*) is at an angle of twenty-two and one-half degrees from a right-angle line to the axis of the shaft *a*, and the line *v y*, of the crank-arm *k*, is similarly at an angle of twenty-two and one-half degrees from a right-angle line to the axis of the shaft *b*, so that the angle of intersection of the crank-arm lines *v w* and *v x* is forty-five degrees.

The line *y w*, of the crank-arm *i*, is at an angle of twenty-two and one-half degrees with the axis-line of the shaft *a*, and the line *y x*, of the crank-arm *l*, is similarly at an angle of twenty-two and one-half degrees with the axis-line of the shaft *b*, so that the angle of intersection of the crank-arm lines *y w* and *y x* is forty-five degrees.

j′ j′ is a circle, whose centre is at the intersection point *i′*, and whose radius is the line *i′ v* or *i′ y*, the line *v y* being its diameter. This circle *j′ j′* represents a perfect sphere, in whose circumference, and in a plane, of which the line *v y* is the horizontal projection, the centre pivot-points of the ball-and-socket joints *r s* and *t u* will always move, when the driving-shaft, of the shafts *a* and *b*, is revolved.

This plane of circular movement of these centre pivot-points, is midway between, and crosses at an angle of forty-five degrees, and at their intersecting line, the planes of rotation of the pivot-pins *j* and *m* of the shafts *a* and *b*.

Fig. 1 shows the shafts *a* and *b*, and the crank-arms, in one position of a revolution, and fig. 2 shows the same in a position one-fourth of a revolution of them from the position shown in fig. 1.

The crank-arms *h* and *k*, in the position shown in fig. 2, being, respectively, partly horizontally opposite to the crank-arms *i* and *l*, are not wholly shown in that figure of the drawing.

When the shafts *a* and *b* are revolved to a position of one-half of a revolution of them from the position shown in fig. 1, the crank-arms *h* and *i* will have exchanged positions with each other, and simultaneously the crank-arms *k* and *l* will also have exchanged positions with each other. Similarly, when the shafts *a* and *b* are revolved one-half of a revolution of them from the position shown in fig. 2, the crank-arms *h* and *i* will have exchanged positions with each other, and, in the same time, the crank-arms *k* and *l* will have exchanged positions with each other.

In the positions of the crank-arms, shown in fig. 2, the dotted lines *m″ m″* show a vertical section through the centre of the crank-arm *l*, on the line *z a′*, and the dotted lines *l″ l″* show a horizontal section through the centre of the crank-arm *l*, on the line *b′ c′*.

The crank-arms change positions relative to one another, and to their respective shafts, by rotary and pivot movements, as follows, viz:

On revolving the shafts *a* and *b*, from the position shown in fig. 1, to the position shown in fig. 2, or one-fourth of a revolution, all the crank-arms will be carried, by rotary movements, one-fourth of a revolution around the axis of their respective shafts, and, simultaneously, each of the pair of crank-arms, *h* and *k*, turns inward on its inner-end shaft-pivot, an angle of fifty-five degrees, and, at the same time, each of the pair of crank-arms, *i* and *l*, turns outward on its inner-end shaft-pivot, an angle of thirty-five degrees, and, simultaneously, each crank-arm turns on its outer-end pivot, an angle of forty-five degrees, in a direction of movement at right angles to its just-described direction of inner-end pivot movement, and each crank-arm simultaneously turns on its outer-end pivot an angle of ten degrees in an inward direction of movement, at right angles to its other just-described direction of outer-end pivot movement.

On revolving *a* and *b*, in the same described direction, one-fourth of a revolution more, all the crank-arms will be carried by rotary movements one-fourth of a revolution more about their shaft-axes, and, simultaneously, each of the pair of crank-arms *h* and *k* will continue its before-described inner-end pivot movements, and turn an angle of thirty-five degrees more on its respective shaft-pivot, and, at the same time, each of the pair of crank-arms, *i* and *l*, will continue its before-described inner-end pivot movements, turning an additional angle of fifty-five degrees on its respective shaft-pivots, and, simultaneously, each crank-arm makes equal and reverse outer-end pivot movements from those just before described of them in the first one-fourth of a revolution of *a* and *b*.

On revolving *a* and *b* in the same described direction, one-half of a revolution more, thus completing one entire revolution of them, all the crank-arms will be carried by rotary movements one-half of a revolution more about their shaft-axes, and, simultaneously, they will all take their first-named positions of inner and outer-end pivoting, (shown in fig. 1,) by equal and reverse inner-end pivot movements, and equal and similar outer-end pivot movements, to those described of them in the first-described one-half revolution of *a* and *b*.

Both of the described inner and outer-end pivot movements of the crank-arms are not oscillating or vibrating pivot movements, in which motion of the crank-arms is suspended, and their inertia required to be overcome at each termination of the pivot movements; but their described pivot movements are without such impediments to steady, uniform, and continuous rotary motion, because they are produced wholly by the outer ends of the crank-arms moving freely and continuously, as described, in a plane of rotation inclined forty-five degrees to, and crossing, as described, the planes of rotary movement in which their inner ends move continuously and freely. The device, therefore, admits of high speed, and uniform, undisturbed, and continuous rotary motions of the shafts *a* and *b* and their connecting parts.

Equal and uniform power and motion may be transmitted from one shaft to the other, as from *a* to *b*, at all points of a revolution of them, by means of the described pivoted crank-shaft coupler. This is evident, without further analysis of the mechanical principles of construction and action of the device, when it is considered that the shafts *a* and *b*, and their connecting parts, are adapted, as shown and described, for free and uninterrupted movements in their required directions of rotation at all points of a revolution of them, and when it is further considered that the described and shown construction and adaptation of the crank-arms (which connect the two shafts, and are the means of transmission of power and motion from one shaft to the other,) are such, that those crank-arms, which are connected with each other, are like and equal, and have the same movements and the same mechanical relations to their respective shafts for transmitting power and motion at all points of a revolution of them.

In order to produce steady rotary movements of the shafts *a* and *b*, and their connecting parts, without shaking or jarring on their supporting journal-boxes, *d* and *f*, the crank-arms and their appendages on each shaft must be balanced at all points of a revolution of the shafts *a* and *b*.

There are various ways and modes in which this may be done.

One way in which each crank-arm and its appendages may be independently balanced at all points of a revolution, and at all required positions of the shafts *a* and *b*, is to extend each crank-arm across its shaft, so that it will, with its appendages, be balanced on its shaft-pivot. The dotted lines, *k′* and *l′*, in fig. 1, show xtension and balancing of the two crank-arms *h*

Another way of balancing the crank-arms is to extend each crank-arm across its shaft, so that the centre of gravity of the two parts of the two crank-arms, lying on the one side of their shaft, shall be, at all points of a revolution, the same distance out at right angles from the axis of their shaft, as is the centre of gravity of the two parts of the same two crank-arms lying on the other opposite side of the shaft. Such a way of balancing is shown in fig. 1, where the centre of gravity of that part of the crank-arm *h*, and the extended part *l'* of the crank-arm *i*, lying on their side of the shaft *a*, is the same distance out in a right-angle line from the axis of the shaft *a*, at all points of a revolution of *a*, as is the centre of gravity of that part of the crank-arm *i*, and the extended part *k'* of the crank-arm *h*, lying on the opposite side of the shaft *a*.

One mode of balancing the crank-arms is to make one crank-arm and its appendages balance the other opposite crank-arm and its appendages on the same shaft, at all points of a revolution of the shafts.

In the position shown in fig. 2, they would of themselves balance each other, because they are alike in construction, and have opposite and like relative positions to their respective shafts. But, in the position shown in fig. 1, they would be out of balance, because they have different relative positions to their shafts, and their centres of gravity are consequently at unequal distances from the axis of the shafts.

Balancing the crank-arms of each shaft by this described mode of balancing, may be done in one way, by proper disposition of weights attached to the crank-arms. Figs. 1 and 2 show such use of weights.

The weights *m'* and *n'*, on the crank-arms *h* and *i* of the shaft *a*, and the weights *o'* and *p'*, on the crank-arms *k* and *l*, are for that purpose. They are, as shown, adjustable both longitudinally and at right angles to their respective crank-arms, but they may be adapted for only one of those adjustments, or for fixed, non-adjustable attachment to their respective crank-arms, and accomplish the same required result of balancing.

The weights are similar and equal, and are placed similarly on their arms, at equal distances from their inner ends, so that when one crank-arm is swung further out from its shaft than the other crank-arm on the same shaft is, the attached weight of the former is thrown nearer the shaft than is the attached weight of the latter arm, as shown in fig. 1.

In such-described use of the weights, it is necessary, that in the position shown in fig. 1, the centre of gravity of the one crank-arm, and its added weight and its appendages, shall be at a point in a line passing through the centre of their shaft-pivot, opposite to and at the same distance out from the axis of its shaft, as is the centre of gravity of the opposite crank-arm, its weight and appendages.

Thus the centre of gravity of the crank-arm *h*, its weight *m'*, and other appendages, when at the point *q'*, will, at all points of a revolution of the shaft *a*, balance the crank-arm *i*, its weight *n'*, and its other appendages, when the centre of gravity of the latter is at the opposite point *r'*.

Similarly when the crank-arm *k*, its weight *o'*, and its other appendages have the centre of their gravity at the point *s'*, they will balance, as required, the crank-arm *l*, its weight *p'*, and its other appendages, when the centre of gravity of the latter is at the opposite point *t'*.

By the same mode of balancing as last described, the crank-arms of each shaft may be so constructed as to balance each other and their appendages at all points of a revolution of the shafts *a* and *b*.

Such a way of balancing is shown in fig. 4, in which the crank-arms are shown curved at their inner forked ends, in such a manner that when one crank-arm of one shaft is swung further out from its shaft than is the other arm of the same shaft, the curved inner end of the former is swung nearer to the shaft than is the curved inner end of the other arm, so that the centre of gravity of the crank-arm *u'*, and its appendages, being at the point *v'*, and the centre of gravity of the crank-arm *w'*, and its appendages, being at the opposite point *x'*, and at the same distance that the point *v'* is from the axis of their shaft *a*, they will balance each other at all points of a revolution; and, similarly, the centre of gravity of the crank-arm *y'*, and its appendages, being at the point *z'*, and the centre of gravity of the crank-arm *a''*, and its appendages, being at the opposite point *b''*, they will also balance each other at all points of a revolution of the shafts *a* and *b*.

In similar construction of the crank-arms, as shown in fig. 4, if weights are required to balance them, they may be used either on the inside of the crank-arms, as the weights *e'' e''*, on the crank-arms *u' w'*, or on the outside of the crank-arms, as the weights *f'' f''*, on the crank-arms *y' a''*.

In fig. 4 is shown a mode of connecting the outer ends of each pair of crank-arms together by pivot-pins, which may be used, in some cases, in substitution for the described ball-and-socket-joint connection of them, but not with equal advantages of accuracy of movements in transmission of power and motion, and durability of the connecting-parts.

In the outer end of the crank-arm *w'* is secured the pivot-pin *c''*, set in the line *e' f'*, centrally with its crank-arm. It passes through the outer end of the crank-arm *a''*, connecting it to the crank-arm *w'*, and forming a pivot for it to turn on.

To admit of both of the before-described outer-end pivot movements of the connected crank-arms, the pivot-pin *c''* must not only be made to turn, but also to rock in the end of the crank-arm *a''*, as by enlarged tapering of the pivot-hole in *a''*, as shown by the dotted lines *d''*, which represent a vertical section on the line *z a'*, through the centre of crank-arm *w'*, when the shafts *a* and *b* are revolved one-fourth of a revolution from the other position shown in fig. 4.

The crank-arms *u'* and *y'* are connected together by the pivot-pin *g''*, similarly as described of the crank-arms *w'* and *a''*.

The shafts *a* and *b* may be placed at other angles than at right angles with each other, and equal and uniform power and motion be transmitted from one shaft to the other by the described pivoted crank-shaft coupler.

To do this, and for suitable and convenient adjustments of the shafts *a* and *b*, and their connecting-parts, so as to be well secured and supported in their proper relative positions, the supporting-plate *g* is used, and it is adapted so that the shaft *a* may be swung as on a pivot at the point *w*, and so that the shaft *b* may also be swung as on a pivot at the point *x*, by means of making the securing-bolts *h'' h'' h'' h''* of the journal-box *d* pass through and be adjustable in curved slots *i'' i''* in the plate *g*, and by means of making the securing-bolts *j'' j'' j'' j''* of the journal-box *f* pass through and be adjustable in similar curved slots *k'' k''* in the plate *g*.

In the described adjustments of the shafts to other angles with each other than a right angle, each shaft should be swung equally toward the other, if more than ninety degrees is required to be turned by it, and from each other if less than ninety degrees is required to be turned by them.

The construction or adjustment of the described pivoted crank-shaft coupler may be, if desirable, made such that the crank-arms of each pair shall be at greater or less angles with each other, and with their shafts, than those shown and described; but in all cases it is necessary that the crank-arms of each pair be of equal lengths, and that they have respectively the same relative positions to their shafts at all points of a revolution.

Moving the shafts *a* and *b* equally and similarly in a longitudinal direction, either inward or outward, would be such an adjustment of the device as would make the crank-arms of each pair at greater or less angles with each other and with their shafts, and the crank-arms of each pair would be of equal length, and have the same relative positions to their shafts at all points of a revolution, and when so adjusted, the device could be used to transmit equal and uniform power and motion from the one shaft to the other, similarly as before described of it.

To enable longitudinal adjustments of the shafts *a* and *b*, adjustable collars may be attached to the shafts *a* and *b*, or to their hubs *c* and *e*, on both sides of the journal-boxes *d* and *f*, and the shafts be adjusted, as required, longitudinally, by moving the collars equally out or in on their hubs or shafts.

In this just before-described different construction or adjustment of the crank-arms, the centre pivot-points of the outer ends of the crank-arms would not move in a true circle, as they do when constructed and adjusted as shown in the drawings.

One pair of the crank-arms, as *h* and *k*, or *i* and *l*, may be dispensed with, and equal and uniform motion and power be transmitted by the remaining pair from one shaft to the other; but the described use of the two pairs is most advantageous, because, when both pairs are used, the transmission of power and motion from one shaft to the other, as from *a* to *b*, is accomplished by distribution and action of equal moments of driving-force at opposite points, on both sides of the shafts, producing thereby the very important result of a balanced transmission of rotary force from one shaft to the other, which is evidently not obtained by the use of only one pair of crank-arms.

The supporting-plate *g* is not indispensably necessary, for the described pivoted crank-shaft coupler may be suitably adjusted and secured in its required position for the purposes described of it, by other means of attachment of supporting journal-boxes.

The shafts *a* and *b* may be secured to their hubs *c* and *e* by any other suitable and commonly-known modes of shaft-connection for such purposes.

The pivot-pins *j* and *m* may be of any other desired form of construction which adapts them for their described purposes, and they may be connected to their hubs *c* and *e* in various ways commonly known for similar purposes.

The crank-arms may be connected in various ways to their inner-end pivots, as by journal-boxes of any known kind, adapted to admit of the described inner-end pivot movements and action, and they may be adapted for taking up wear of their frictional surfaces, or for adjustments of the inner ends of the crank-arms to their described required positions.

The ball-and-socket joints at the outer ends of the crank-arms may be made adjustable in ways commonly known, so as to enable taking up for wear of their frictional surfaces, or for adjustments of the outer ends of the crank-arms to their described required positions.

Other modes than those described may be used, both of construction and of connection of the crank-arms to their shafts or to each other, when both the construction and connection of the crank-arms adapt them to produce substantially the same described mechanical action, in transmission of power and motion from the one shaft to the other, which they are employed to connect.

I claim as new, and of my invention—

1. Transmitting, from one revolving shaft of machinery to another, equal and uniform rotary motion and power at all points of a revolution of them, whether the shafts are set in lines at right angles to each other, or at various other angles of divergence from each other, by means of one or more pairs of pivoted crank-arms, which are employed and adapted to connect the shafts together, and to produce thereby substantially the same mechanical action as that described in the described transmission of rotary motion and power from the shaft *a* to the shaft *b*.

2. The employment of one or more pairs of pivoted crank-arms, for connecting together two revolving shafts of machinery, and the adaptation of each pair of crank-arms to their shafts and to each other, substantially as set forth, so that the shafts so connected may be adjusted and set in lines at right angles to each other, or at various other angles of divergence from each other, and equal and uniform rotary motion and power be transmitted thereby from one shaft to the other, at all points of a revolution of them, substantially as set forth.

3. Joining together the outer ends of the crank-arms by the described connections, or by other connections which enable the described or equivalent rotary and pivot movements of the outer ends of the crank-arms, for the purposes set forth, and I further claim said outer-end connections of the crank-arms, in combination with the described inner-end connections of them to their shafts, or with other inner-end connections, which enable the described inner-end rotary and pivot movements of them, for the purposes set forth.

4. The one pair of crank-arms *h* and *k*, or their equivalents *i* and *l*, in combination with the shafts *a* and *b*, when the said pair of crank-arms is connected together and to the shafts *a* and *b*, substantially as described, and for the purposes set forth.

5. The two pairs of crank-arms *h k* and *i l*, in combination with the shafts *a* and *b*, when said crank-arms are connected together and to the shafts *a* and *b*, substantially as described, and so as to enable thereby a balanced transmission of rotary force from one shaft to the other, substantially as described.

6. The weights *m' n'* and *o' p'*, in combination with the crank-arms *h i* and *k l*, when employed substantially as described, and for the purposes set forth.

7. The supporting-plate *g*, in combination with the described shaft-coupler, with the curved slots *i'' i''* and *k'' k''*, substantially as described, and for the purposes set forth.

8. The crank-arms *u'* and *w'*, with their similar and connected crank-arms *y'* and *a''*, when constructed substantially as shown and described, and adapted in their combination together and with the shafts *a* and *b*, for transmission of rotary force from one shaft to the other, as described, and so as to balance each other on their shafts, substantially as described.

9. Extending each crank-arm of the described shaft-coupler across its shaft, so as to be thereby balanced on its shaft, substantially as described, and for the purposes set forth.

10. Extending each crank-arm across its shaft, so that the two parts of the two cranks-arms lying on the one side of their shaft shall balance, as required and described, the two parts of the same crank-arms lying on the other opposite side of their shaft.

11. Balancing the crank-arms on their shafts, by means of weights, adjusted on and attached to the crank-arms, substantially as described.

12. Constructing the crank-arms substantially as shown and described, so that one crank-arm of one shaft shall balance, as described, the other opposite crank-arm of the same shaft.

13. The pivoted crank-shaft coupler, consisting of the hubs *c* and *e*, pivot-pins *j* and *m*, pivoted crank-arms *h i* and *k l*, ball-and-socket joints *r s* and *t u*, and balancing-weights *m' n'* and *o' p'*, all supported in journal-boxes *d* and *f*, and connecting the shafts *a* and *b*, substantially as described; and for the purposes set forth.

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