T. WEAVER.

Spherical Gear or Universal Joints.

No. 145,075. Patented Dec. 2, 1873.

Fig. 1

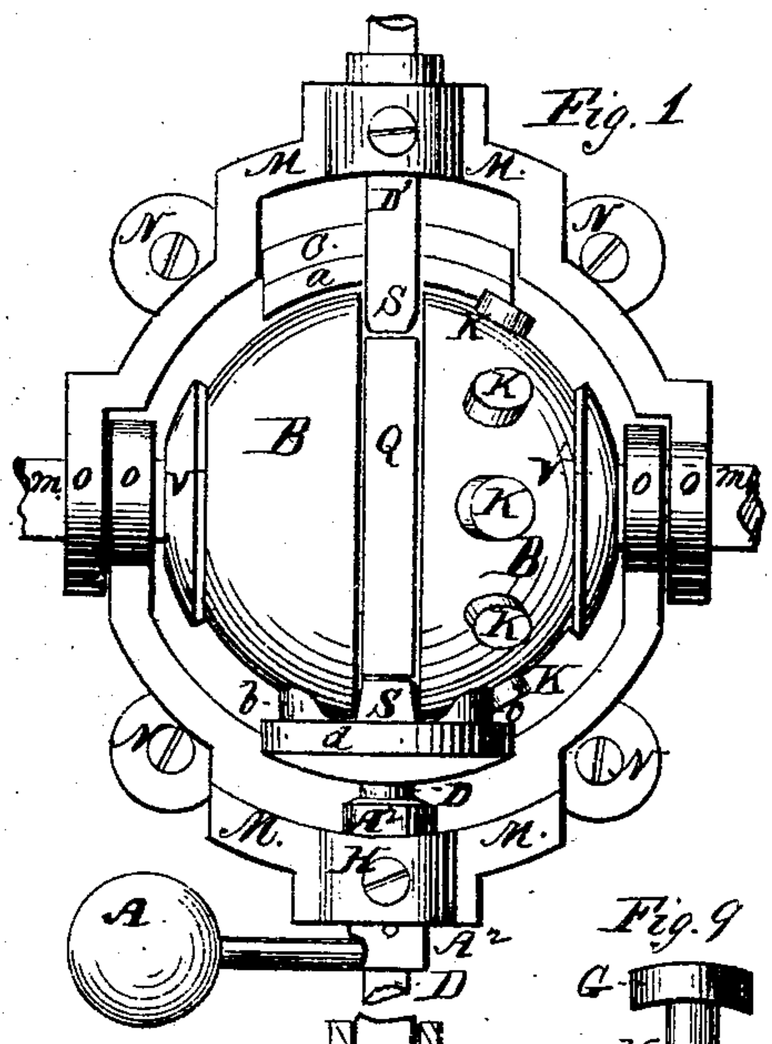


Fig. 2

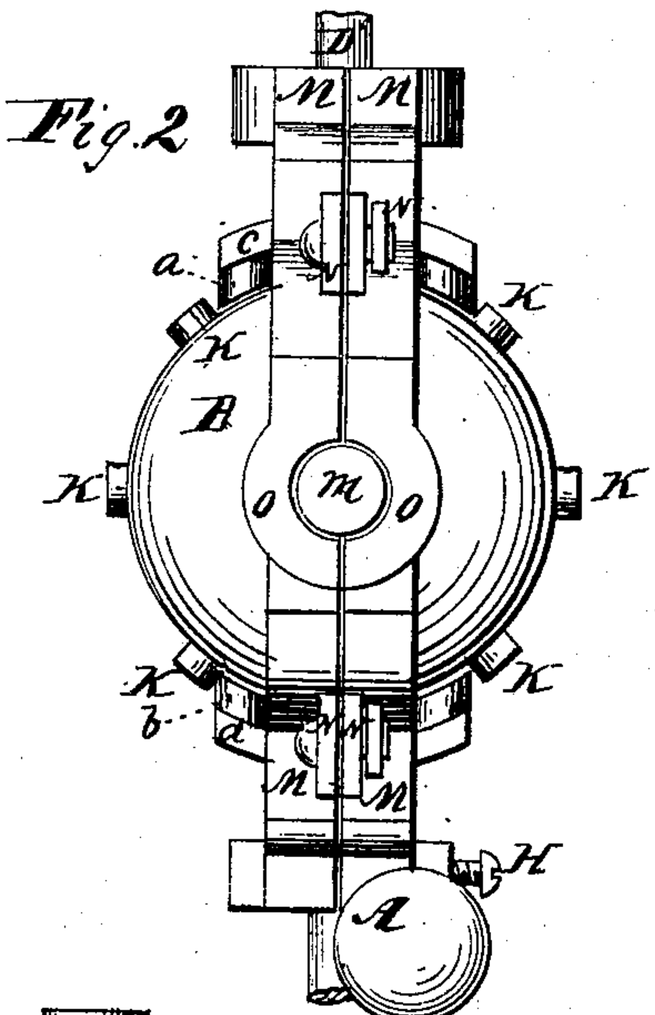


Fig 3

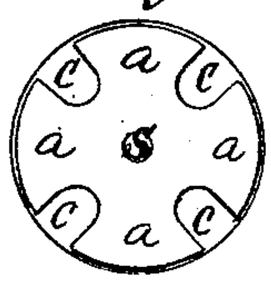


Fig. 4

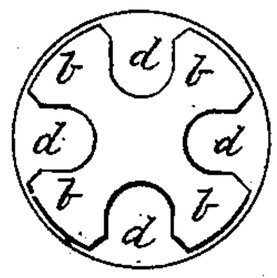


Fig. 9

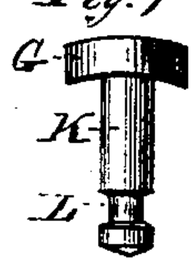


Fig. 5

Fig6

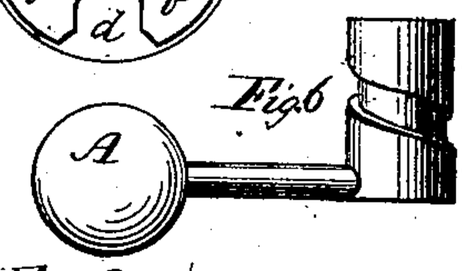


Fig. 8

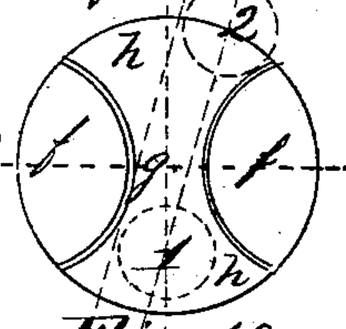


Fig. 7

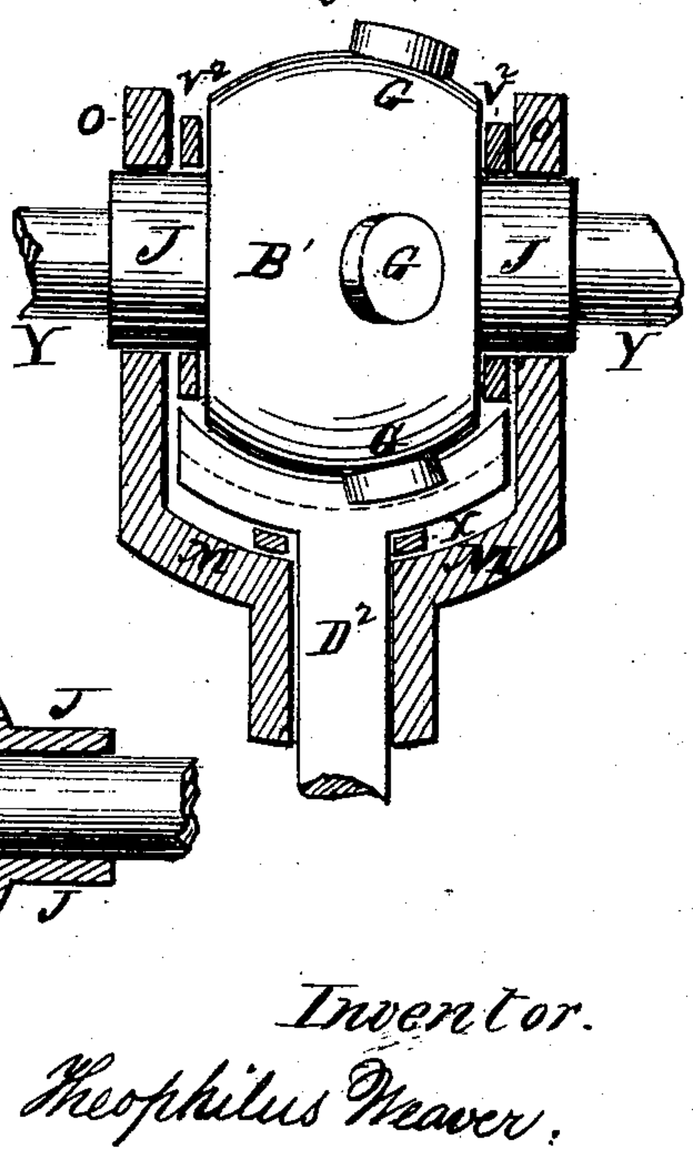
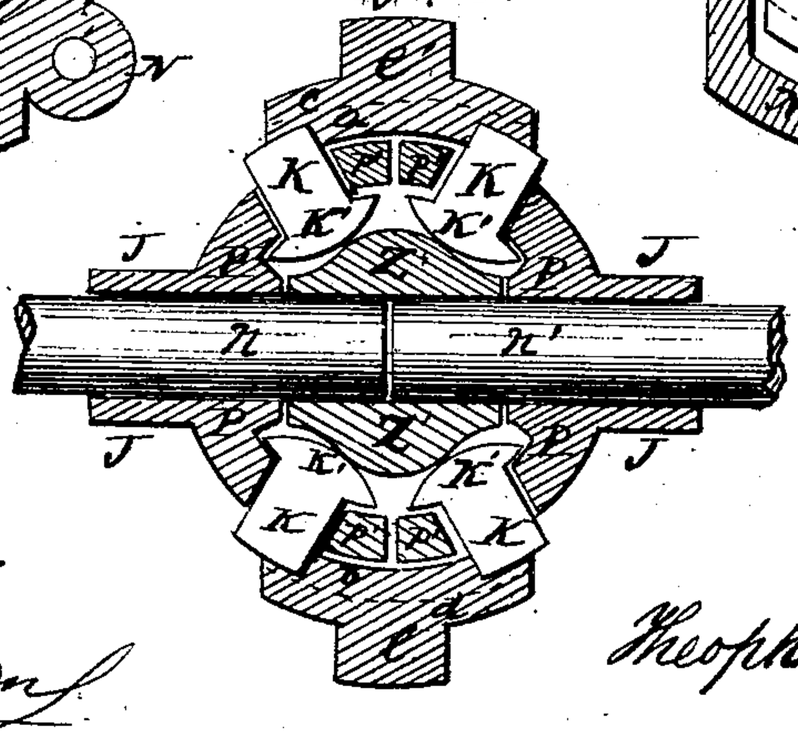


Fig. 10.



Witnesses.

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UNITED STATES PATENT OFFICE.

THEOPHILUS WEAVER, OF HARRISBURG, PENNSYLVANIA.

IMPROVEMENT IN SPHERICAL GEARS OR UNIVERSAL JOINTS.

Specification forming part of Letters Patent No. **145,075**, dated December 2, 1873; application filed May 16, 1873.

To all whom it may concern:

Be it known that I, THEOPHILUS WEAVER, of the city of Harrisburg, county of Dauphin and State of Pennsylvania, have invented certain new and useful Improvements in Spherical Gears or Universal Joints, of which the following is a specification:

The nature of my invention relates to the means whereby the transmission and the modification of motion is effected from the sphere or spherical spindle to the matrix or sphere mate, or from the latter to the former; also, to the means whereby the friction is reduced to the lowest limit; also, to the means whereby the sphere or spindles are connected with the matrix or matrices. The first part of my invention, therefore, relates to certain projections or trunnions on the sphere or spherical spindle or spindles, which are either fixed or roller form, discous or bolt form, permanent or detachable. The second part thereof relates to certain pockets, paths, or grooves between the lobes or subdivisions of the concave face of the matrix or sphere mate. The third part thereof relates to certain concavo-convex washers to relieve the friction of the sphere or spherical spindles about their journals. The fourth part thereof relates to certain means to hold or keep the trunnions swiveled in the spherical shell. The fifth part thereof relates to a double tier of trunnions, and to the subdivision of the sphere into segments or spindles. The sixth part thereof relates to certain two-parted stirrups or articulating frames, whereby the joints are made flexible and easily detachable. The seventh part thereof relates to a cut-off device, whereby the mates are detachable from the contact of the trunnions, either at will or automatically, by a certain limit of the stress, in the latter case acting as a dynamic governor. The eighth relates to the arrangement of the trunnions in circles on the sphere, more or less distant from, and parallel to, the maximeter score. The ninth relates to a stile or shaft end projected from the face of the sphere mate, and made to trace in a groove on the sphere, by which the lateral strain of the gears is resisted. The tenth relates to a truncated spherical gear, foreshortened at the poles or journals. The eleventh relates to a shaft-coupling in the dummy, by which the loosely-inserted shaft ends are kept aligned, the dummy being kept in proper position over the line of the shaft-union by the inner surfaces of the spindles, which are rigidly attached to said shafts at points to cause the exterior of the spindles to form a skeleton sphere, which is encompassed by the hinged hangers, which serve not only to attach the sphere mates, but also to couple the spindles toward the sphere-center.

In the accompanying drawings, Figure 1 is a perspective view of the parts composing a single or double universal joint, the cut-off device, one pinion being shown in vertical section. Fig. 2 is a perspective view of the same, presenting the stirrups edgewise to view. Figs. 3 and 4 are front views of the sphere mates, or pinions, or female gears. Fig. 5 is a vertical section or plan of the subjects of Fig. 1. Fig. 6 is a top view of the cut-off lever and sleeve. Fig. 7 shows a truncate-sphere spindle in perspective, and its attachment in vertical section. Fig. 8 is a front view of a binary or two-lobed pinion, the mate of the spindle shown in Fig. 7. Fig. 9 is a view of a tablet-crowned trunnion. Fig. 10 is a plan of a subdivided sphere, or its spindles, trunnions, dummy, pinions, and shaft-joints.

This specification is prefatory to a system of gears termed "transit-gears," so termed because the trunnions on the sphere, by its revolution, cross the concave face of the matrix, in the chord-lines that may be determined upon, either by the form, size, and position of the lobes or tablets in the matrix, or by the number and size of, and by the position of the girdle of, the trunnions on the sphere or spherical spindle. The trunnion-girdle is more or less offset from the central scribe on the sphere, here termed the maximeter score, because it is the line of greatest velocity, and they may be arranged alternately on opposite sides of the maximeter score; or sets of trunnions may be so arranged alternately across said score, thus initiating another system, termed "zigzag gears." If the trunnions are located on the maximeter score, the matrix-shaft angle changed, a number of pole-gears will be produced, which are the converse of such set forth in my patent of August 1, 1871, to the ecliptic system of which it treats. The transit

system is the corollary or sequel, the latter being also indicated in my patent of March 26, 1872, on cream-freezer.

The sphere or spherical spindles herein shown are right sphere-joints. The ball B, Fig. 1, is solid or shell-formed, has groove Q on the maximeter score, to receive the stiles S of the mate, or its projecting shaft, to resist lateral strain thereby; has trunnions K projecting radially from its convex surface; has shaft *m* rigidly fixed in its axis; has washers V^1, or concavo-convex plates, having eyes to pass the sphere-shaft through, employed to relieve the friction of the sphere in the hanger; or the washers may be the convex protrusions of plugs or dummies in the ball or shell, as hereinafter explained.

The matrices or pinions shown in Figs. 1, 2, 3, 4, and 5 are concavo-faced to match the ball-surface, are applied as loose plates on angular-shouldered shafts, or are rigidly fastened on their shafts, and may be hub-formed, as shown in Figs. 7 and 10, may be provided with stiles S cast thereon, or shaft projections thereon, or without stiles, when the trunnions are close to the maximeter. The matrices are trenched, grooved, or lobed radially by straight or curved cuts, forming insteps *c* or *d*, the lobes *a* or *b* being the relievo part of the matrix face left stand, whose outer ends are more or less clipped, flared, or pitched as ports to the insteps. The insteps are so made and located that each trunnion may step in and gage it nicely—that is, fill it—while the succeeding trunnion is engaging the succeeding instep. The travel of the trunnions across the matrix-face in the chord-lines thereof differs from the travel of teeth on the peripheries of wheels in the degree that the chord differs from the arc which it subtends, and consequently the number of teeth is greatly diminished and their strength greatly increased, and the relative velocities of the gears is greatly differentiated. The grooves shown in Figs. 3 and 4 stop short of the center of the matrix; but they may be made to cut away the matrix-center, according to the position of the trunnion-girdle, thus carrying the differentiation of velocities to a high degree. In all cases the instep or groove must be as near said center as the trunnions are from the maximeter score. The division of the matrix into lobes may be made to produce more or less than four lobes, as will be shown hereinafter.

The stirrups M (shown in Figs. 1, 2, 5, and 7) are longitudinally two-parted frames, suitably shaped, to embrace the gears coupled by them, and are the skeletons of masks, by which the gears may, in some cases, be enveloped, shielded, and muffled. The limbs O take hold on the ball-shaft hinge form, and their opposite ends or yokes form two-parted bearings for the hubs and shafts of the pinions. They are joined together by hasps N N, or their equivalents, and may, therefore, be attached to, or detached from, the shafts which they support without undoing the keys thereon. They present the driver front face, or in apposition to the driven part, by aligning their axes at right angles to each other, allowing the pinions to be gyrated about the ball-axle.

The cut-off device consists mainly of a weighted lever-arm, A, on a trunk or sleeve, A^2, which has on its cylindrical body a spiral track, A^1, as shown in Fig. 6. A screw or stub, H, in the stirrup-yoke serves to pass the said sleeve out and in through the shaft-bearing when the arm A is vibrated; consequently the shaft swiveled in said sleeve and its pinion is made to engage the ball-gear, or to be disengaged at will therefrom. The pitch of said spiral A^1 is such that violent strain acts to disengage the gears. The amount of strain requisite for the strength of the gear may be regulated by making the weight adjustable, thus converting the cut-off into a dynamic governor.

To adapt the gears for heavy work, the number of trunnions may be diminished and their caliber increased, as shown in Figs. 7, 8, 9, at G, and the sphere may be truncated, as at B′, being provided with heavy journals, J, and the matrix (shown in Fig. 8) is adapted accordingly, having two oppositely-arranged similar circular lobes, *f*, and a bold flaring trunnion-way, *h*, across its disk.

To describe this binary pinion, find the chord-line on the ball-surface from the center of one trunnion to the center of its adjacent one, with half said line set off two points from the matrix-center on the matrix diameter. Diminish said half by half the diameter of the pinion-crown, which gives the radius with which to draw the tablet circle or arc from said points. It will be observed as the trunnion-crown is increased the tablet or lobe is diminished, and vice versa. It will also appear plain in Fig. 8 that trunnion 1 fully passes one tablet over the center the instant trunnion 2 is in place to engage the other tablet. Thus one rotation is effected for every two trunnions on the sphere or spherical spindle.

The trunnions may be fixed stubs or tablets, or the projecting ends of bolts swiveled in the sphere-shell or spherical spindles. In Fig. 5 the trunnions K are swiveled, have convex crowns, cylindrical bodies, ending in conical tips, which ride on the sphere-shaft, and have chamfered necks L, against which the tread Z of the cylindrical or plug washer V steps, to keep the bolts from dropping out of their cells, but allowing them to revolve; and said washer extends its convex end against the stirrup-arm, or its equivalent, by which it is kept in its place. The washer V Z also serves as a dummy to complement the sphere, and to assist the key to poise the ball-shell on the shaft. In Fig. 7 the flanges V^2 V^3 may be made as the exterior of dummies, to fill the recessed trunk B′. In Fig. 10 the dummy Z′ is made bulb-formed, and is made to receive the ends of the shafts *n n′*, to either of which it may be fixed rigidly and left free on the other,

and it acts as a prop to keep the trunnions K in the shell-cells by allowing their oval heads K′ to bear on the bulb. In Fig. 9 the convex crown G of the trunnion is made tablet or washer form, its shank K and chamfer L being made and applied substantially as shown in Fig. 5.

In all the modified forms of the trunnions they are made to project moderately from the spherical surface, and in good machinery are to be made of steel or case-hardened iron. They are in transit-gears all set more or less from the maximeter score. They are made removable for repairs, for change of speed, or change of direction of motion.

The plan shown in Fig. 10 is substantially the device shown in Fig. 1 compounded on itself, consisting of the spherical spindles P J, their mates *l l′*, a double tier of trunnions, K, the dummy Z′, the stirrups and cut-off being omitted; and the rims P′ of the spindles are kept narrowly separated by the dummy-hub between the spindle-hubs, the dummy thus acting as an internal washer.

The results of the joint shown in Fig. 7, with one pinion, or simply ball and its mate, are miter equivalents, and rate as 1 to 2, and may be as 1 to 3, 1 to 4, 1 to 5, &c., and, by assuming an odd number of trunnions, the rates may be as 2 to 3, 2 to 5, 2 to 7, &c. The results of the articulation shown in Fig. 1 are two contrary miter equivalents, and rate as 1 to 2, with variations, as last recited.

The results of compounding the parts, as shown in Fig. 10, are not only the results recited of Figs. 7 and 1, the cut-off being used, and one tier of trunnions made removable, but there is an additional complex result, as follows: Both pinions and spindles being engaged, there is the equivalent of quadruple miter, shafts *n* and *n′* being contrary, as well as the pinions *l l′*, and, in addition, the pinions stay poised above the sphere, relatively at rest with each other, at any angle at which the cut-off happens or is made to place them in the act of engaging them with the ball. Shafts *n n′* may, therefore, be made a carrier when pinion *l* is the driver, and the shaft of pinion *l′* will stand out unsupported from the sphere at any desired angle. The functions of these gears are, therefore, general in machine building, and in the equipments for operations in machine establishments of all kinds.

The gears herein set forth are not simply couplings or joints, but transmitters of any desired rate of velocity. The trunnion-crowns and colliding surfaces of the gears are true spherical segments. The truncated sphere B′, Fig. 7, is a spherical spindle, essentially perfect as a spherical arbor. The sphere and its mate are termed "male gear" and "female gear," respectively. The mate differs from a discous wheel as essentially as the sphere differs from a plane, the chord-line travel of the trunnions being possible only in the spherical arrangement of the parts engaging each other. The concavo-convex washers are employed not only as friction-relievers, but as blocks to regulate the instep of the trunnions, by causing the hanger to be shifted more or less, and to a nicety in relation to the sphere-center, the lateral strain being the only strain requiring this remedy. By lateral strain is meant the effort to push the mate axis from the plane of the maximeter score.

I do not claim coupling pins or bolts loosely applied in oblong or flaring eyes to connect spherical male and female butts on shafts dependent for their retention in the eyes on the union of the male and female; but

Having thus set forth the nature of transit-gears, and drawn a few inferences, what I claim as my invention, and as new and useful, is—

1. Trunnions or projections as equipments on a spherical gear, when retentively inserted and closely fitted to constitute the gear an independent traveler, and as definitely radially-poised cylindrical detents to transmit the energy of the driver to the driven gear transitively, substantially as and for the purpose herein set forth.

2. The spherically-dished female gear provided with any conformation of insteps between the straight or curved subdivisions of its concave surface, to effect the transit of the male-gear trunnion-crowns in the imaginary chord-lines, herein set forth, and for the purpose substantially as described.

3. The concavo-convex washers, in combination with the male-gear journals and the hanger-arms as friction-relievers, and blocks to gage the instep of the trunnions by the lateral adjustment of the female gear, as herein described.

4. The dummies or sphere complements, when employed to keep the trunnions inserted in the spherical shell, all constructed and applied substantially as herein set forth.

5. The trunnions, when provided with chamfers, or their equivalents, as herein set forth.

6. In combination with spherical gears, the arch-formed stirrups, each provided with arms to hug the sphere appositely, employing the sphere-shaft as the hinge-pintle, about which the stirrup-frame swings, and provided with the bearing for the shaft of the sphere mate, so arranged as to present said shaft radially toward the sphere-center, in the manner as and for the purpose herein set forth.

7. The dynamic governor or cut-off composed of the gravity-lever A, the spirally-grooved sleeve A^1 A^2, and the detent H, in combination with the stirrup M and the male and female gears, all constructed and arranged, to effect the conjunction and disjunction of the gears, in the manner herein set forth.

8. The spherical hub-formed spindles P P′ J, constructed as and for the purpose herein set forth.

9. The combination of ball B, trunnions K, stirrups M, pinions *a e* and *b d*, and cut-off A A^1 A^2 H, substantially as herein set forth.

10. The combination of two equipped spin-

dles, P P′ J, with each other, with the interposed dummy Z′, and the pinions *l l′*, as and for the purpose herein set forth.

11. The trunnion shown in Fig. 9, tablet-crowned, and bolt-formed shank, as herein set forth.

12. The arrangement of the trunnions on a spherical gear in circles smaller than, parallel to, and offset from, the maximeter score, as and for the purpose herein set forth.

13. The stile or shaft projection S on the sphere mate, in combination with the groove Q, girdling the sphere, for the purpose set forth.

14. The truncated sphere B′, or spherical periphery, provided with trunnions, substantially as herein shown and described.

15. The combination of the shafts *n* and *n′* with each other, when aligned by the perforated dummy Z′, or its equivalent, in the interior of the male gear, and when connected exteriorly by means of the rigidly-attached spindles P P′ J, and one or more female gears, *l l′*, all encompassed by the stirrups M, substantially as herein shown and set forth.

16. A couple of spherical gears (male and female) equipped with trunnions and insteps for trunnions, respectively, applied to each other transversely as an articulation on mid-shaft about the sphere by an encompassing hanger or hangers, substantially as herein set forth.

In testimony that I claim the foregoing as my invention I hereunto affix my signature this 13th day of May, 1873.

THEOPHILUS WEAVER.

Witnesses:
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JNO. B. NICHILOS.