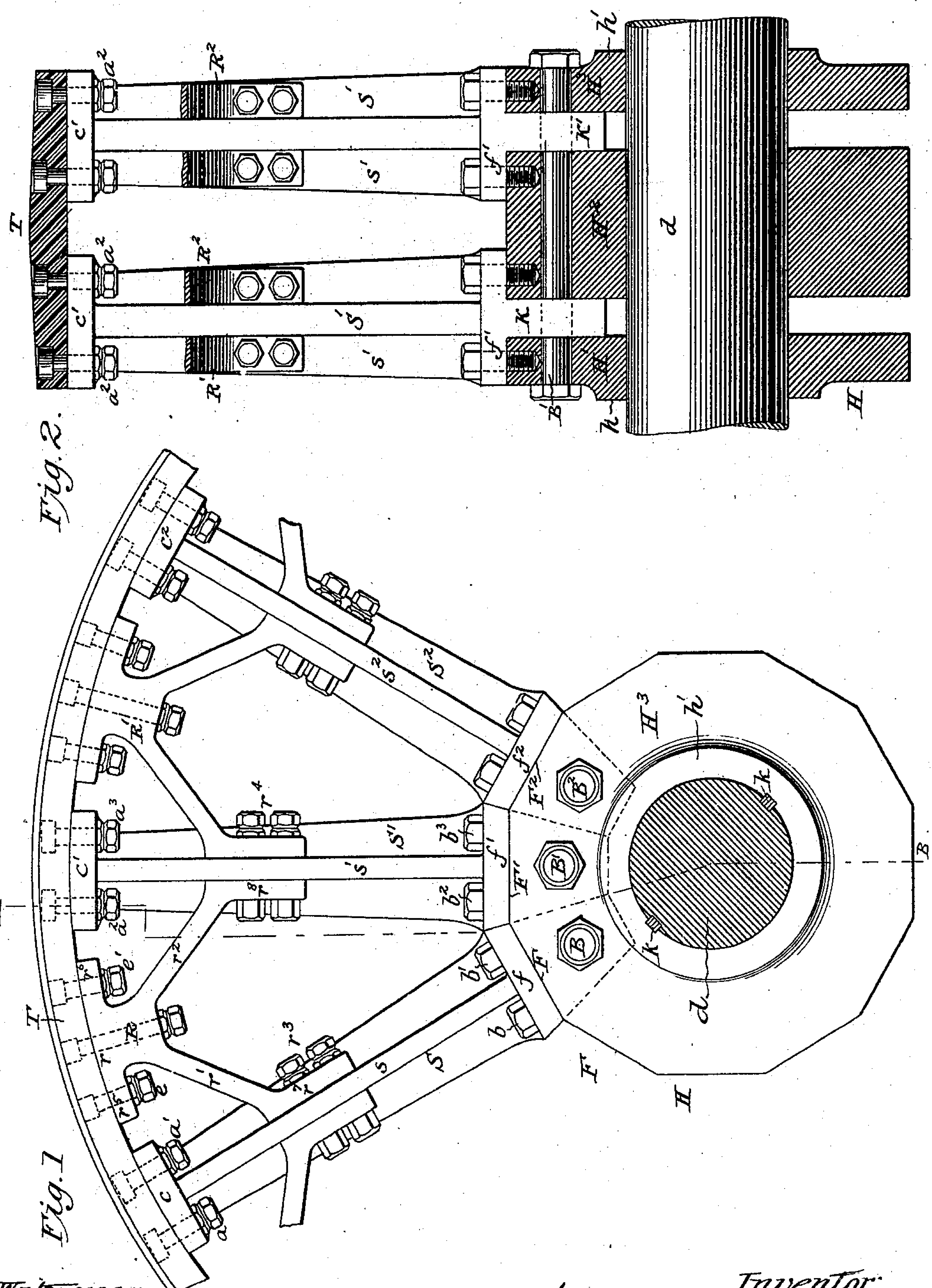
No. 670,385. Patented Mar. 19, 1901.

C. H. HOWLAND-SHERMAN.

FLY WHEEL.

(Application filed Nov. 22, 1899.)

(No Model.) 2 Sheets—Sheet 1.



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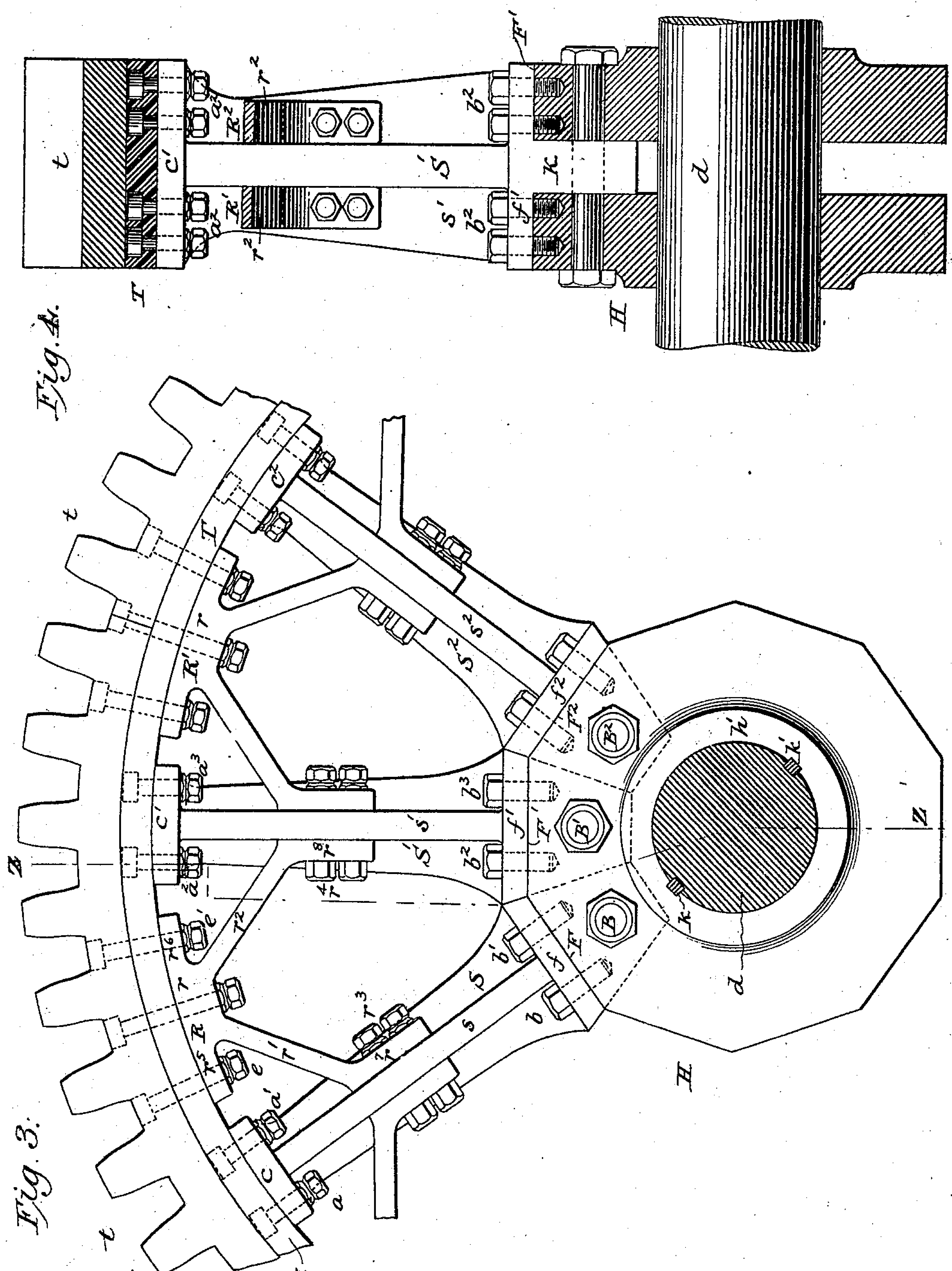

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UNITED STATES PATENT OFFICE.

CHARLES H. HOWLAND-SHERMAN, OF PATHFINDER, DISTRICT OF COLUMBIA, ASSIGNOR OF ONE-FOURTH TO GEORGE H. HOWARD, OF WASHINGTON, DISTRICT OF COLUMBIA, AND SAMUEL G. B. COOK, OF LONDON, ENGLAND.

FLY-WHEEL.

SPECIFICATION forming part of Letters Patent No. 670,385, dated March 19, 1901.

Application filed November 22, 1899. Serial No. 737,919. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. HOWLAND-SHERMAN, a citizen of the United States, residing at Pathfinder, in the District of Columbia, have invented a new and useful Improvement in Fly-Wheels, of which the following is a specification, reference being had to the accompanying drawings and to the letters of reference marked thereon.

My invention pertains to non-explosive wheels, pulleys, or gears of relatively large diameters, and is particularly designed as an improvement applicable to the construction of fly-wheels or main driving-spurs, such as are employed in central power or lighting stations. These principal power-wheels are driven at high circumferential velocities and the greater proportion of their heavy masses constantly rotates at radii which are so great as to develop enormous centrifugal bursting moments, resulting in stresses which frequently cause explosions, attended by disastrous loss of life or property, in the ordinary operation of this important class of machinery.

The object of this invention is to obviate the possibility of such accidents by means of a structure normally resisting all the disintegrating forces through tensional members coinciding with the lines of the actual force components concerned in a manner affording larger factors of safety than can be attained by the use of structures chiefly subject to transverse strains or bending moments. I accomplish these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of a segment of a fly-wheel made upon this system, showing the composite character of its hub, arms, compound stay-pieces, and rim. Fig. 2 is a vertical section on the line A B, Fig. 1, showing the longitudinally-trifurcated hub inclosing the keystone-bases of the arms, the shear and tensional boltings assembling the same to the hub, the double parallel series of arms, portions of the compound stay-pieces in elevation and in section, and a section of the rim, showing the manner of attaching the same to the arms. Fig. 3 is a side elevation of a segment of a main driving-spur gear built upon this method, showing the similar composite structure of hub-arms and rim and additionally indicating the method of attaching to the latter the tooth-segments of the gear. Fig. 4 is a vertical section on the line Z Z, Fig. 3, showing the longitudinally-bifurcated hub, the single row of arms attached thereto in a manner similar to those shown in Fig. 2, portions of the compound stay-pieces in elevation and in section, and a section of the rim with its superiorly-attached tooth-segment.

Similar letters of reference indicate similar parts throughout the several views.

The shaft *d* engages by means of any suitable keys *k k'* with the hub H, as clearly shown in Figs. 1 and 3. The hub H preferably consists of three disks H' H^2 H^3, Fig. 2, having transversely-registering tangential flats F F', &c., adapted to seat the flanges *f f'*, &c., of the arms S S', as shown in Figs. 1 and 3, and to inclose the keystone-bases K K' of said arms in the manner shown in Figs. 2 and 4, being assembled to said bases by the shear-bolts B B', &c., and to said flanges by the tension-bolts *b b'*. The exterior parts of the hub H bear annular collars *h h'*, cast and turned upon the same in the usual manner, as shown in the several figures, and adapted to bear laterally against the pedestals or journals of the shaft. This hub H is preferably made of some readily-worked material, such as strong gray iron, and is adapted to be cast and bored or turned upon an ordinary lathe to receive its shaft *d*, assembled by its bolts B B', and then to have all of its flats F F' simultaneously planed to correct tangents for seating the base-flanges *f f'*, &c., of the arms S S'.

The arms S S', as shown in the several views, are preferably constructed with longitudinal webs and transverse ribs *s s'*, &c. The base-flanges *f f'* of the arms form coincident faces with the sides of the keystone-bases K K', as shown by the front elevations of such flanges appearing in the sectional views and by the side lines and dotted lines continuous therefrom in the side elevations. The cap-flanges *c c'* are preferably rectangular bodies integral with and formed transversely upon the ends of the rib-and-web structure, as plainly indicated in all the views. The keystone-bases K K′ are adapted to be inclosed accurately within the parts of the hub H and secured thereto by the shear-bolts B B′. Said keystone-bases are so constructed that the double shear draft of the bolts B, &c., through the bottom of said bases along lines coaxial with the spoke shall be exactly balanced by the double shear of the bolt-shanks, and thus absorb the full value under tensional strain of the bases K K′. The base-flanges $f f'$ of the arms S, &c., are fastened to the respective flats of the hub H by the tension-bolts b b', as shown in Figs. 1, 2, and 3, in such manner that the tensional value of said bolts shall be in balance with the shearing stress of the sections parallelizing their bores through said flanges. The combined effect of these two latter sets of fastenings is to cause the boltings B b b', related to each arm, to fully absorb the ultimate tensional strength of the greatest section modulus of the arms S S′. The arms S have a materially-reduced radius of gyration at their outer ends in the manner usual to such designs, said reduction being in the present instance consistent with the only force which can reach the arms at this point. The entire draft of the cap-flanges c, with the correspondingly-reduced section modulus of the arm, is tensionally absorbed by the boltings a a', &c., whose function is to attach the rim T to said cap-flanges in the manner clearly shown in Figs. 1 and 4.

The rim T is preferably constructed of merchant steel, as indicated in the sectional views. From such materials it is readily cold-bent to the large radii of principal power-wheels and is less subject to disintegrating shocks than crystalline metals, like cast-iron. There is, however, nothing to prevent the use of cast-iron rims of proportionally heavier weight in this system as effectively as in other wheels or gears.

The compound stay-pieces R R′ (shown in elevation in Figs. 1 and 3 and partially in section in Figs. 2 and 4) are employed to resolve the tensional draft sustained under centrifugal tendencies by the rim-segment to which each arm is centrally related into its natural components, which are respectively and equally referred along the legs of said compound stay-pieces from their proper points of attachment by the bolts r^3 r^4 to the arms S S′, &c., to the rim at points intermediate to the attachments of said arms. The effect of this structure is to prevent the centrifugal bursting forces present in operating the wheel from forming the rim between the arms into that ovoid contour which experts agree is always precedent to its explosion. This is accomplished by dividing the strains upon the rim into exactly twice the number of points at which it would be possible to take them up by any plain arm structure and by the more important fact that at any instant of position where the bursting moment exceeds the normal resistance of the wheel structure it is immediately resolved and referred along the nearest stay to the adjacent arms and stay-pieces, and is so continuously referred as an immediate transmission of effort around the entire structure of the wheel, being equally absorbed by the same in every direction in all its parts practically at the same instant. It will be obvious that the point of application of the arms of the stay-pieces to the ribs s s' of the arms S S′ is governed solely by and varies directly according to the angularity of the spokes, which automatically change the direction of the component forces, with the lines of which said stay-arms coincide. These compound stay-pieces R R′ consist, essentially, of the cap-pieces r, supporting by a strong neck the legs r' r^2, terminating in the feet r^7 r^8. The cap-pieces have flanges r^5 r^6, through which the boltings e e' attach said cap-pieces to the rim T in the case of fly-wheels, as shown in Fig. 1, and in the case of driving-spurs, as shown in Fig. 3, said bolts e e' additionally pass through the rim T and attach to the latter the tooth-segments t.

The stay-pieces R R′ are preferably constructed as forgings from ordinary merchant steel, which material can be in the case of excessive bursting moments advantageously substituted by hammered Bessemer. It will be evident that castings of any crystalline or semicrystalline character, even cast-steel, will be illy suited to the construction of these stay-pieces, for the reason that their flanges r^5 r^6 necessarily sustain a short but important bending moment, in relation to which the elastic limit of said flanges must be highly factored for security.

It will be noted that the example of the fly-wheel designed in accordance with my invention as illustrated in Fig. 2 has a double parallel series of arms, as elsewhere mentioned, this being for the purpose of enabling it to securely carry a relatively broad rim, such as high horse-power belts demand, without being compelled to adopt arms of so heavy weight as to prohibit the employment of a sufficient number to judiciously absorb the centrifugal strains. This double parallel series is especially adapted to use in wheels undergoing the highest centrifugal strains when made in accordance with this invention, for the reason that the included angle of each pair of arms can be reduced to the extreme minimum, accompanied by a corresponding reduction in value of the greatest section modulus of arm, with safety, while the interstitial stay-pieces so frequently resolve the forces into their components that practically the entire rim is under a perfect state of tensional equilibrium in respect to the supporting structure. The single-arm form of my invention illustrated in Fig. 4 necessitates arms considerably more weighty than any two of the parallel arms used in the form shown in Fig. 2 and also necessitates these heavier arms making much larger included angles, as shown in Fig. 3, and sustaining the rim at fewer points of support. Clearly this latter form of my invention is adapted only to structures such as slower heavy gears undergoing relatively constant stresses, to which it would afford sufficient security; but in the case of gears running at the highest circumferential velocities the adoption of the same arm structure shown in Figs. 1 and 2 is recommended.

In the shop practice of constructing large power-wheels and main driving-spurs on this system no hand-finishing whatever is required at any point, the operations being all limited to the simple ones of planing, turning, and boring throughout the assembly. This insures a minimum cost for the structure, which, nevertheless, attains a degree of strength not believed to be possible by any previously-known means for making similar wheels, not excepting the cases of the most complex designs thus far introduced.

I do not wish to limit myself to the particular details of construction shown in the accompanying drawings, desiring to reserve the right to properly vary the structure without departing from the spirit of my invention.

My invention in wheel construction, it is believed, affords a new and reliable solution of safely making such wheels to withstand practically the stresses of any attainable speeds and bursting moments, while costing much less than many structures previously proposed or used and developing a capacity of wear greater in proportion to the more perfect equilibrium in which it holds the destructive forces jointly developed by work and centrifugal tendencies.

Having thus described my invention, I claim—

1. In a wheel structure, the combination of a hub consisting of separate disks having tangential flats; arms having base-flanges adapted to seat upon the tangential flats of the hub, said arms being further provided with keystone-bases; shear-boltings passing through the hub-disks and the keystone-bases of the arms, and tensional boltings securing the base-flanges of the arms to the tangential flats of the hub, substantially as set forth.

2. In a wheel structure, the combination of a hub consisting of separate disks having tangential flats; arms having end beveled base-flanges adapted to seat upon the tangential flats of the hub, a beveled edge of each of said base-flanges fitting against the adjacent edge of the adjoining base-flange, said arms being further provided with keystone-bases; shear-boltings passing through the hub-disks and the keystone-bases of the arms, and tensional boltings securing the base-flanges of the arms to the tangential flats of the hub, substantially as set forth.

3. In a wheel structure, the combination of a hub; arms; a rim; shear and tensional boltings for securing the arms to the hub; stay-pieces, each one being fitted between two arms of said wheel structure and the rim, and bolts for connecting said stay-pieces to the arms and to the rim, respectively, substantially as set forth.

4. In a wheel structure, the combination of a hub; arms; a rim; shear and tensional boltings for securing the arms to the hubs, said arms having cap-flanges; stay-pieces, each one being fitted between two arms of said wheel structure and the rim thereof; bolts for connecting said stay-pieces to the arms and to the rim, respectively, and bolts for connecting the cap-flanges of the arms to the rim, substantially as set forth.

5. In a wheel structure, the combination of a hub consisting of separate disks having tangential flats; a rim; arms having base-flanges adapted to seat upon the tangential flats of the hub, said arms being further provided with keystone-bases; shear-boltings passing through the hub-disks and the keystone-bases of the arms; tensional boltings securing the base-flanges of the arms to the tangential flats of the hub; stay-pieces, one being fitted between each pair of arms and the rim; bolts for connecting said stay-pieces to the arms and rim, respectively, and bolts for connecting the arms to the rim, substantially as set forth.

6. In a wheel structure, the combination of a hub consisting of separate disks having tangential flats; a rim; arms having base-flanges adapted to seat upon the tangential flats of the hub, said arms being further provided with keystone-bases; shear-boltings passing through the hub-disks and the keystone-bases of the arms; tensional boltings securing the base-flanges of the arms to the tangential flats of the hub; stay-pieces, one being fitted between each pair of arms and the rim; shear-boltings for connecting said stay-pieces to the arms; tensional boltings connecting said stay-pieces to the rim, and tensional boltings for connecting the arms to the rim, substantially as set forth.

7. In a wheel structure, the combination of a hub, arms fastened to said hub, a rim fastened to said arms, and compound stay-pieces, each having, respectively, a cap attached to said rim, and legs secured to and between two of the arms, substantially as set forth.

In testimony whereof I hereunto set my hand.

CHARLES H. HOWLAND-SHERMAN.

Witnesses:
C. B. BULL,
G. H. HOWARD.