

H. S. HELE-SHAW.  
FRICTION CLUTCH, BRAKE, OR THE LIKE.

APPLICATION FILED MAR. 21, 1902.

5 SHEETS—SHEET 1.

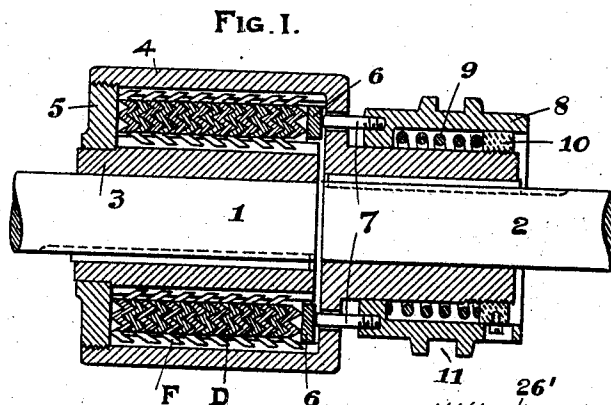


FIG. II.

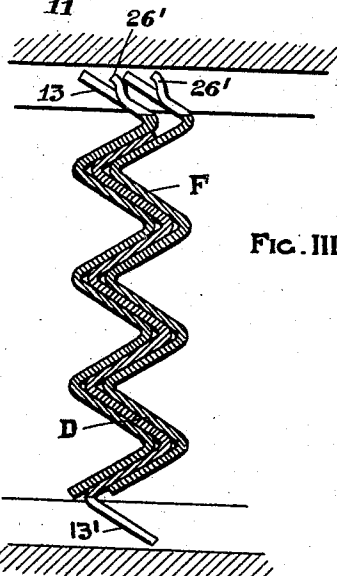
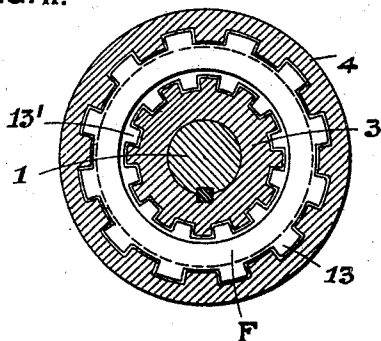


FIG. III.

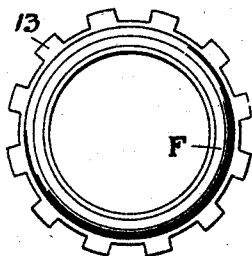
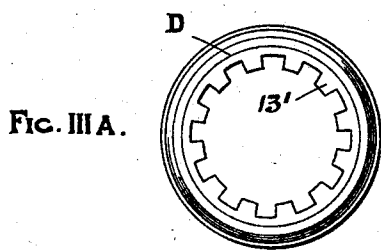


FIG. III B.

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5 SHEETS—SHEET 2.

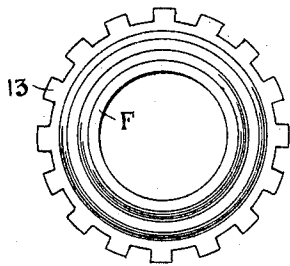


FIG. XII A.

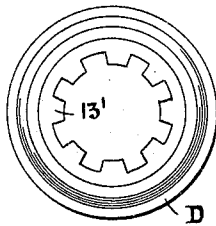


FIG. XII B.

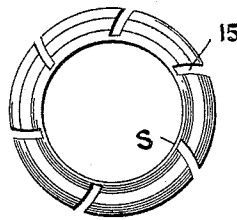


FIG. XII C.

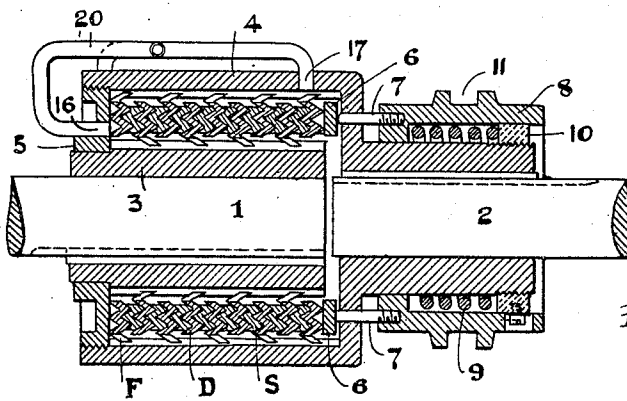


FIG. IV.

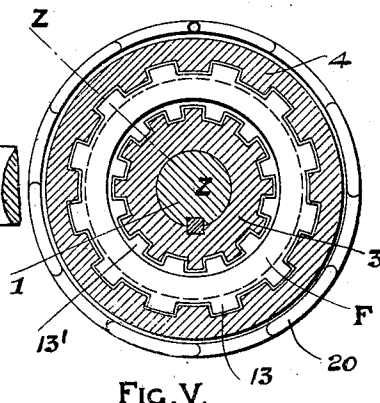


FIG. V.

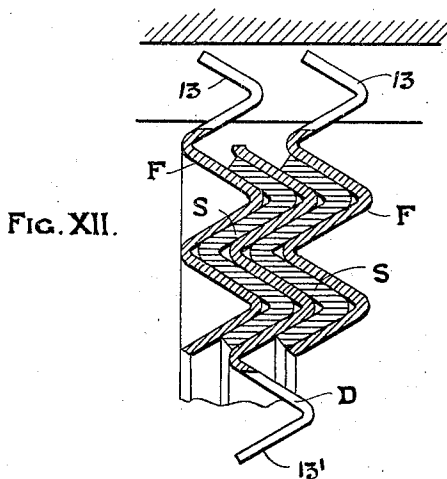


FIG. XII.

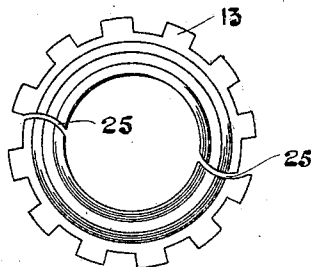


FIG. XVII.

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5 SHEETS—SHEET 3.

FIG. XIII A.

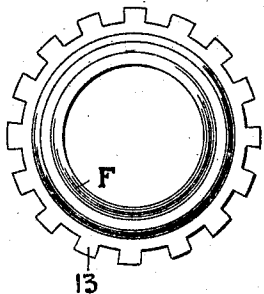


FIG. XIII B.

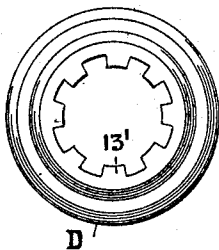


FIG. XIII C.

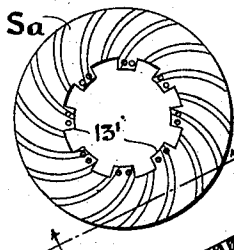


FIG. XIII D.

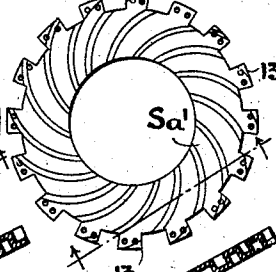


FIG. XIII F.



FIG. XIII E.

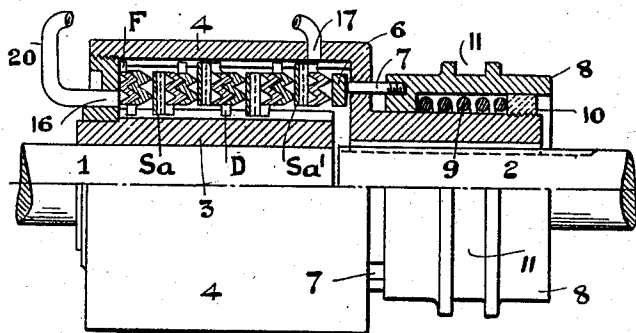


FIG. VI.

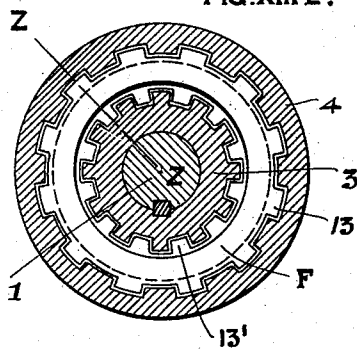


FIG. VII.

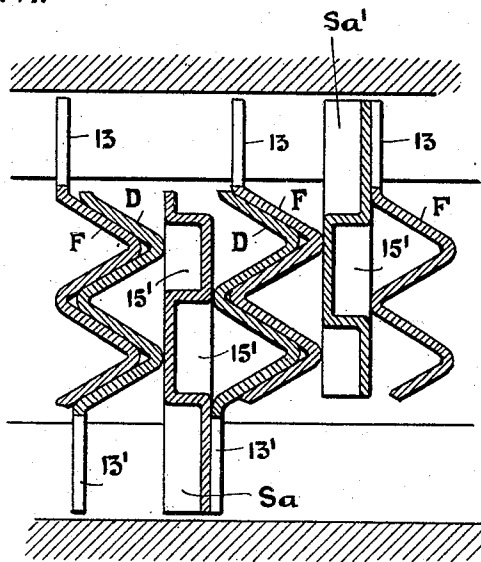


FIG. XIII.

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5 SHEETS—SHEET 4.

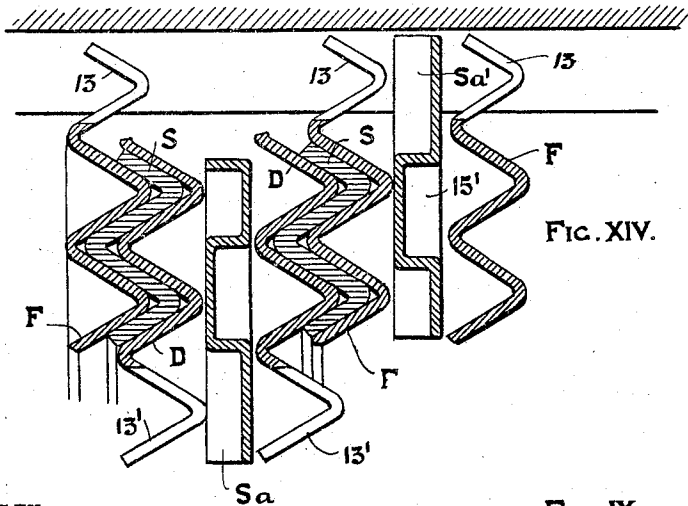


FIG. XIV.

FIG. VIII.

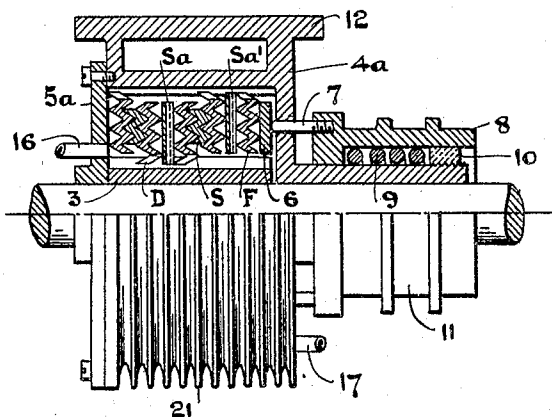


FIG. IX.

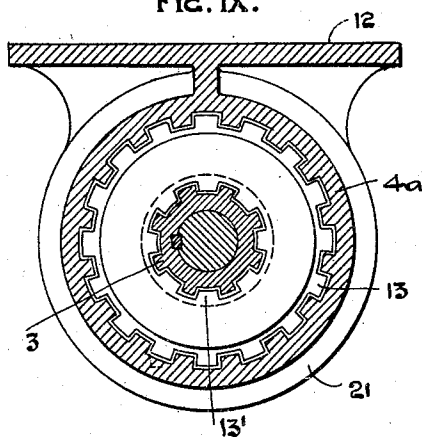


FIG. XIVA.

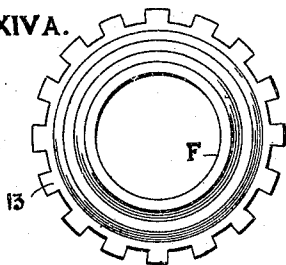


FIG. XIV B.

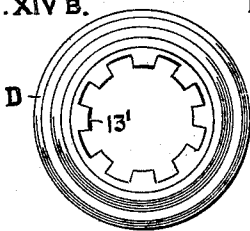


FIG. XIV C.

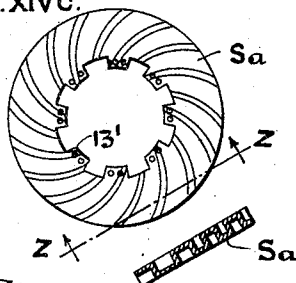


FIG. XIV D.

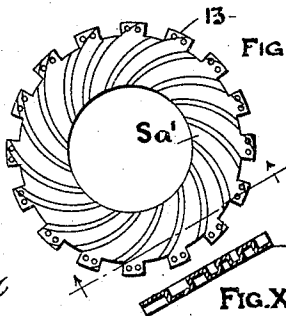


FIG. XIV E.

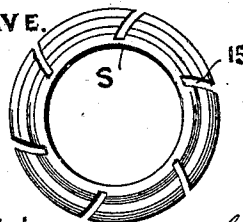


FIG. XIV F.



FIG. XIV G.



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5 SHEETS—SHEET 5.

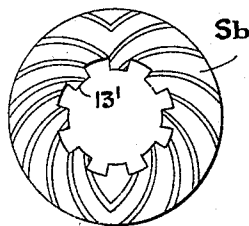
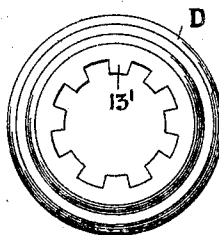
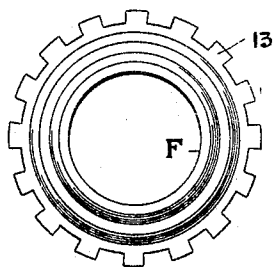
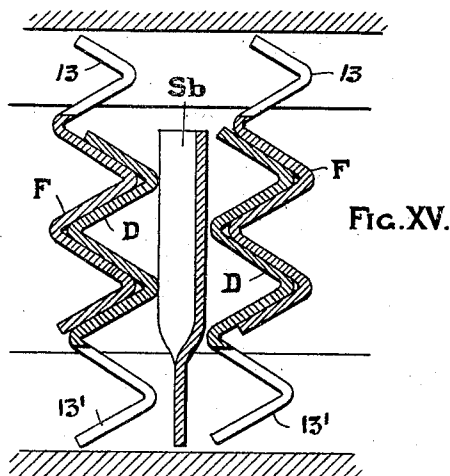
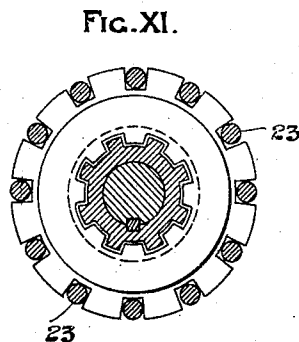
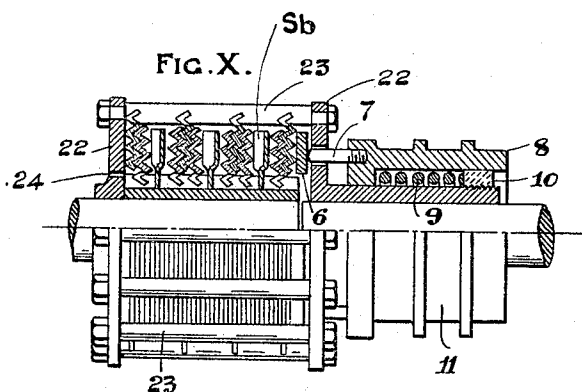


FIG. XVA.

FIG. XV B.

FIG. XVI.

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# UNITED STATES PATENT OFFICE.

HENRY SELBY HELE-SHAW, OF LIVERPOOL, ENGLAND.

## FRICITION CLUTCH, BRAKE, OR THE LIKE.

No. 795,974.

Specification of Letters Patent.

Patented Aug. 1, 1905.

Application filed March 21, 1902, Serial No. 99,384.

*To all whom it may concern:*

Be it known that I, HENRY SELBY HELE-SHAW, a subject of the King of Great Britain, residing in Liverpool, in the county of Lancaster, England, have invented certain new and useful Improvements in Friction Clutches, Brakes, or the Like, and in Means for Cooling such Apparatus by the Circulation of a Fluid Therein, of which the following is a specification.

This invention relates to friction clutches, brakes, and the like apparatus, and to means for cooling such apparatus by the circulation of a fluid.

A friction-clutch and a brake constructed in accordance with my invention are in many respects identical, the main difference being that the portion which is attached to the follower-shaft in the case of a clutch is a fixture in the case of a brake. In the latter case there is necessarily much evolution of heat when in action, and it becomes necessary to provide for its dissipation. The same is true also in the case of a clutch where a slipping connection is required, for which purpose my invention is especially applicable.

In the accompanying drawings, Figure I is a central longitudinal sectional view through the casing and associated parts of my clutch. Fig. II is a cross-sectional view of Fig. I. Fig. III is a detail sectional view of the identically-corrugated clutch-plates. Figs. III<sup>A</sup> and III<sup>B</sup> are face views of the disks of Figs. I, II, and III. Fig. IV is a central longitudinal sectional view of a clutch like that shown in Fig. I, showing liquid-circulating connections. Fig. V is a cross-sectional view of Fig. IV. Figs. VI and VII are views similar to Figs. I and II of a modified arrangement of disks and spacing-disks. Figs. VIII and IX are views of still another modification, these views being similar to Figs. I and II. Figs. X and XI are respectively a longitudinal sectional view and a cross-section of a modification in which the casing is not in the form of a closed receptacle. Fig. XII is an enlarged detail sectional view of one arrangement of the disks. Figs. XII<sup>A</sup>, XII<sup>B</sup>, XII<sup>C</sup> are face views of the disks of Figs. IV and XII. Fig. XIII is an enlarged detail sectional view of the arrangement of disks shown in Fig. VI. Figs. XIII<sup>A</sup>, XIII<sup>B</sup>, XIII<sup>C</sup>, XIII<sup>D</sup> are detail face views of the disks of Figs. VI and XIII. Figs. XIII<sup>E</sup> and XIII<sup>F</sup> are sectional views of the disks shown in Figs. XIII<sup>C</sup> and XIII<sup>D</sup>. Fig. XIV is an enlarged sectional detail view

of the arrangement of disks shown in Fig. VIII. Figs. XIV<sup>A</sup>, XIV<sup>B</sup>, XIV<sup>C</sup>, XIV<sup>D</sup>, and XIV<sup>E</sup> are face views of the disks shown in Figs. VIII and XIV. Figs. XIV<sup>F</sup> and XIV<sup>G</sup> are sectional views of the disks of Figs. XIV<sup>C</sup> and XIV<sup>D</sup>. Fig. XV is an enlarged sectional detail view of the arrangement of disks shown in Fig. X. Figs. XV<sup>A</sup> and XV<sup>B</sup> are face views of the disks shown in Figs. X and XV. Fig. XVI is a face view of one of the spacing-disks of the arrangement shown in Fig. X. Fig. XVII is a face view of one of the disks, illustrating the fact that any of the disks may be made in halves.

Throughout the drawings the same parts are indicated by the same reference-characters.

Referring in the first place to Figs. I, II, III, III<sup>A</sup>, and III<sup>B</sup>, 1 is the driver, and 2 is the follower-shaft. 3 is a cylindrical sleeve keyed to the shaft 1, and 4 is a cylindrical casing prolonged into a boss which is keyed to the shaft 2. The exterior of the sleeve 3 and the interior of the casing 4 are cut with numerous feather-ways, as shown in Fig. II, and the annular space between the sleeve and the casing is closed by the screwed cap 5. At the other end of this annular space is located the annular plate 6, against which abut the pins 7, fixed to the spring-case 8. This case is urged to the left by the spiral spring 9 abutting against the collar 10, and it is controlled in the usual way by a forked lever engaging in the groove 11. The annular space between the cap 5 and the plate 6 is filled with two sets of friction-disks D and F, the thickness of which is exaggerated in Fig. I for the sake of clearness. The set D is made with internal projections 13' (see Fig. II) to engage with the feather-ways of the sleeve 3, and their peripheries are clear of the casing 4. The other set, F, is similarly feathered by their external projections 13 to the casing 4 and they clear the sleeve 3.

The disks are formed of sheet metal, being sufficiently thin to be punched or sheared from the sheet at one operation by a pair of press-cutting dies, and they are deeply angularly corrugated, as shown in Fig. 3, by being pressed between a pair of positive and negative dies. The corrugations are circumferential and concentric, and it is important to note that all the disks of both sets are facsimiles so far as the corrugation is concerned—that is to say, they may all be pressed between the same dies. The corrugations

extend over the projections 13 or 13', and this has the double advantage of stiffening the latter and also of permitting the same pair of dies to be used for disks of different diameters. It will be noted that the disks are of uniform thickness except in so far as the metal may be thinned in the pressing process.

Several important advantages result from the formation of the disks out of sheet metal, as described. The cost is only a small fraction of that of machined disks. They are much thinner than would be practicable if they were machined, and this permits a very large number to be fitted in a clutch of moderate length, and as the engaging pressure required varies inversely as the number of engaging surfaces only a comparatively small engaging pressure is required. Further, an inspection of Fig. III will make it clear that the uniformity of thickness insures proper clearances at the apices of the corrugations, so that they cannot bottom and they must engage with a true wedge action, while the apices where the metal is most likely to be distressed in the pressing process are protected from wear. When the spring-case 8 is left uncontrolled, the shafts are engaged by the pressure of the spring 9, transmitted through the pins 7 and plate 6, and there is then little friction between the controlling-fork and the groove 11, as there is no pressure between them. To disengage, the spring-case is forced to the right by the controlling-lever, relieving the engaging pressure. There is then considerable pressure between the controlling-fork and the groove; but as the latter is then at rest there is no friction.

The gripping power of the clutch being very great, I find that it acts quite efficiently even when the friction-surfaces are well lubricated.

In order to convert the arrangement shown into a brake, it is only necessary to fix the shaft 2 or to secure the casing 4 to a fixed abutment.

In the arrangement described there are only shaft-disks D and casing-disks F, alternately arranged. In the following modifications what are termed "spacing-disks" are used. These are placed between the disks D and F or between two disks D or two disks F and are adapted to promote the circulation of a cooling or lubricating fluid and when placed between the disks D and F also to take up wear.

In the modification illustrated in Figs. IV, V, XII, XII<sup>A</sup>, XII<sup>B</sup>, and XII<sup>C</sup> the arrangement of the shafts 1 and 2, the sleeve 3, casing 4, cap 5, plate 6, pins 7, spring-case 8, spring 9, collar 10, and groove 11 and the disks D and F, with teeth 13' and 13, Figs. XII<sup>A</sup> and XII<sup>B</sup>, are all as already described in connection with Figs. I, II, and III. In this case, however, a spacing-disk S is placed between each pair of disks D and F. This spacing-disk is shown in Fig. XII<sup>C</sup>, and it is pro-

vided, preferably, with a gap 15, which forms in each spacing-plate a channel for the lubricating and cooling fluid to flow between the plates D and F. In order to provide a complete circuit for the fluid, a cooling-pipe 20 connects the central part 16 of the casing 4 to the outer part 17, and the pipe extends round the casing, so as to expose a large surface. The relative rotation of the different parts and the cooling effect of the external part of the pipe 20 tend to promote a circulation of the cooling and lubricating liquid.

In the form illustrated in Figs. VI, VII, XIII, XIII<sup>A</sup>, XIII<sup>B</sup>, XIII<sup>C</sup>, XIII<sup>D</sup>, and XIII<sup>E</sup> the spacing-disks are placed between pairs of disks D or pairs of disks F, and with the exception of this difference in the arrangement of the disks this form of clutch is exactly similar to that already described in reference to Figs. I and II.

The disks D and F, Figs. XIII<sup>A</sup> and XIII<sup>B</sup>, are similar to the disks D and F already described. The spacing-disks S<sup>a</sup> and S<sup>w</sup> have a series of spiral corrugations forming channels 15' formed in them by pressing between dies or the like. The one set of spacing-disks, S<sup>a</sup>, have internal teeth 13' and the other set, S<sup>w</sup>, external teeth 13, as shown in Figs. XIII<sup>C</sup> and XIII<sup>D</sup>, and each of the set S<sup>a</sup> is placed between a pair of D disks and each of the set S<sup>w</sup> between a pair of F disks. The channels 15' in both S<sup>a</sup> and S<sup>w</sup> may be so arranged as to cause an outward flow of the liquid, the circuit of flow being completed through the pipe 20, as described in connection with Figs. IV and V, or the channels in the respective sets S<sup>a</sup> and S<sup>w</sup> may be so arranged as to produce the one an outward flow and the other an inward flow.

In the modification shown in Figs. VIII, IX, XIV, XIV<sup>A</sup>, XIV<sup>B</sup>, XIV<sup>C</sup>, XIV<sup>D</sup>, and XIV<sup>E</sup> there are both kinds of spacing-disks—that is to say, a set S, Fig. XIV<sup>E</sup>, one of which is placed between a disk D and a disk F, a set S<sup>a</sup>, Fig. XIV<sup>C</sup>, one of which is placed between pairs of D disks, and a set S<sup>w</sup>, Fig. XIV<sup>D</sup>, one of which is placed between pairs of F disks. The disks D and F, Figs. XIV<sup>A</sup> and XIV<sup>B</sup>, and the spacing-disks S, S<sup>a</sup>, and S<sup>w</sup> are the same as the similarly-designated disks already described. The casing 4<sup>a</sup> is, however, provided with a foot 12 and the end cap 5<sup>a</sup> is now bolted on. The casing is also provided in this modification with radiating fins 21. In other respects the parts 6, 7, 8, 9, 10, and 11 are the same as already described.

In the modification shown in Figs. X, XI, XV, XV<sup>A</sup>, XV<sup>B</sup>, and XV<sup>C</sup> the casing does not form a closed vessel, but is formed of two end pieces 22, united by a series of bars 23, which take the place of the teeth in the casing 4 already described. In this form the cooling fluid is air, and the spacing-disks S<sup>b</sup>, Fig. XVI, are adapted to act as fans to force the air out radially between the plates D and F, Figs.

XV<sup>a</sup> and XV<sup>b</sup>, and inlets 24 are provided by which the air enters the casing. In other respects the parts 6, 7, 8, 9, 10, and 11 are similar to those already described.

Any of the disks described may be made in halves, as shown in Fig. XVII, the line of division 25 being a line which is not a radial line. The object of this is to enable the disks to be got into or out of place in cases where it is inconvenient or impracticable to slip them over the end of a shaft—as, for instance, on a railway-axle. The line of division is a spiral, as shown, to prevent the edges from fouling.

The disks shown in the various figures may be split in the way indicated; but in many cases, especially where there is heavy wear and facility for renewals is required, I prefer to make the shaft and casing disks of a hard material, as steel, and to interpose these split wearing-disks of copper or other softer material between the surfaces, which would otherwise rub over each other. These wearing-disks being softer than the others will take most of the wear and their form facilitates renewal.

With the object of freeing the disks when disengaged I in some cases interpose light springs between, say, all the casing-disks. These springs are external to the shaft-disks and free of them. A simple method is to punch tongues 26' in the metal and to give these an elastic set out of the plane of the disk.

Having now fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated facsimiles of each other and means for pressing the disks together, substantially as described.

2. In combination, a shaft, a casing, corrugated shaft-disks, and corrugated casing-disks, said disks being formed of sheet metal and being facsimiles of each other so far as their corrugations are concerned and means for pressing the disks together, substantially as described.

3. In combination, a shaft, a casing, shaft-disks, and casing-disks, both sets of disks being of flexible material and provided with facsimile corrugations and means for pressing the disks together, substantially as described.

4. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, said casing being adapted to inclose the disks and to contain the lubricating fluid and means for pressing the disks together, substantially as described.

5. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the

disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

6. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, said casing being adapted to inclose the disks and to contain the lubricating fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

7. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, said casing being adapted to inclose the disks and being provided with an inlet and an outlet and connecting pipe for the circulation of the lubricating and cooling fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

8. In combination, a shaft with a feathered sleeve keyed thereto, a casing having featherways cut therein, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other and provided with teeth adapted to fit respectively the feathered sleeve and the feathered casing, said casing being adapted to inclose the disks and being provided with an inlet and an outlet and connecting pipe for the circulation of the lubricating and cooling fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

9. In combination, a shaft, a casing, shaft-disks, casing-disks, and spacing-disks, all said disks being corrugated facsimiles of each other, and means for pressing the disks together substantially as described.

10. In combination, a shaft, a casing, corrugated shaft-disks, corrugated casing-disks, and corrugated spacing-disks, all said disks being formed of sheet metal and being facsimiles of each other so far as their corrugations are concerned, and means for pressing the disks together substantially as described.

11. In combination, a shaft, a casing, shaft-disks, casing-disks, and spacing-disks, all sets

of disks being of flexible material and provided with facsimile corrugations, and means for pressing the disks together substantially as described.

12. In combination, a shaft, a casing, shaft-disks, casing-disks, and spacing-disks, all said disks being corrugated and in respect to the corrugations facsimiles of each other, said casing being adapted to inclose the disks and to contain the lubricating fluid, and means for pressing the disks together substantially as described.

13. In combination, a shaft, a casing, shaft-disks, casing-disks, and spacing-disks, all said disks being corrugated and in respect to the corrugations facsimiles of each other, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

14. In combination, a shaft, a casing, shaft-disks, casing-disks, and spacing-disks, all said disks being corrugated and in respect to the corrugations facsimiles of each other, said casing being adapted to inclose the disks and to contain the lubricating fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

15. In combination, a shaft with a feathered sleeve keyed thereto, a casing having featherways cut therein, shaft-disks, casing-disks, and spacing-disks, all said disks being corrugated and in respect to the corrugations facsimiles of each other, and said shaft-disks and casing-disks being provided with teeth adapted to fit respectively the feathered sleeve and the feathered casing, said casing being adapted to inclose the disks and being provided with an inlet and an outlet and connecting pipe for the circulation of the lubricating and cooling fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

16. In combination, a shaft, a casing adapted to contain a lubricant, corrugated shaft-disks, and corrugated casing-disks, said disks being formed of sheet metal and being facsimiles of each other so far as their corrugations are concerned, spacing-disks provided with a lubricating-channel, and means for pressing the disks together substantially as described.

17. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks, and casing-disks, both sets of disks being of flexible material and provided with facsimile corrugations, spacing-disks provided with a lubricating-channel, and means for pressing the disks together substantially as described.

18. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, spacing-disks provided with a lubricating-channel, said casing being adapted to inclose the disks and to contain the lubricating fluid, and means for pressing the disks together substantially as described.

19. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, spacing-disks provided with a lubricating-channel, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

20. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, spacing-disks provided with a lubricating-channel, said casing being adapted to inclose the disks and to contain the lubricating fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

21. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other, spacing-disks provided with a lubricating-channel, said casing being adapted to inclose the disks and being provided with an inlet and an outlet and connecting pipe for the circulation of the lubricating and cooling fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

22. In combination, a shaft with a feathered sleeve keyed thereto, a casing having featherways cut therein, shaft-disks and casing-disks, said disks being corrugated and in respect to the corrugations facsimiles of each other and provided with teeth adapted to fit respec-

tively the feathered sleeve and the feathered casing, spacing-disks provided with a lubricating-channel, said casing being adapted to inclose the disks and being provided with an inlet and an outlet and connecting pipe for the circulation of the lubricating and cooling fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

23. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks, casing-disks, and spacing-disks, all said disks being corrugated and in respect to their corrugations facsimiles of each other, and said spacing-disks having a gap cut away to form a lubricating-channel, and means for pressing the disks together substantially as described.

24. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks and casing-disks, all aforesaid disks being corrugated and in respect to the corrugations facsimiles of each other, and spacing-disks, having a series of lubricating-channels formed by corrugating them, and placed between pairs of disks of the same set, and means for pressing the disks together substantially as described.

25. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks, casing-disks, spacing-disks placed one between each shaft and casing disk, all aforesaid disks being corrugated and in respect to the corrugations facsimiles of each other, and spacing-disks, provided with lubricating-channels formed by corrugating them, and placed one between pairs of disks of the same set, and means for pressing the disks together substantially as described.

26. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks, casing-disks, spacing-disks, placed one between each shaft and casing disk, all aforesaid disks being corrugated and in respect to the corrugations facsimiles of each other, spacing-disks, provided with lubricating-channels formed by corrugating them, and placed one between pairs of disks of the same set, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

27. In combination, a shaft, a casing, shaft-disks, casing-disks, spacing-disks placed one between each shaft and casing disk, all aforesaid disks being corrugated and in respect to the corrugations facsimiles of each other, spacing-disks, provided with lubricating-channels formed by corrugating them, and

placed one between pairs of disks of the same set, said casing being adapted to inclose the disks and to contain the lubricating fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

28. In combination, a shaft, a casing, shaft-disks, casing-disks, spacing-disks placed one between each shaft and casing disk, all aforesaid disks being corrugated and in respect to the corrugations facsimiles of each other, spacing-disks, provided with lubricating-channels formed by corrugating them, and placed one between pairs of disks of the same set, said casing being adapted to inclose the disks and being provided with an inlet and an outlet and connecting pipe for the circulation of the lubricating and cooling fluid, and means for pressing the disks together comprising a spring-case, a spring normally pressing the case toward the disks, said spring-case having pins to transmit the spring-pressure to the disks and a groove by which it may be held against the spring-pressure in the inoperative position, substantially as described.

29. In combination, a shaft, a casing, shaft-disks and casing-disks, said disks being corrugated facsimiles of each other, springs interposed between adjacent pairs of disks of the same set, and means for pressing the disks together substantially as described.

30. In combination, a shaft, a casing, shaft-disks, casing-disks, and spacing-disks, all said disks being corrugated facsimiles of each other, and springs interposed between adjacent pairs of disks of the same set, and means for pressing the disks together substantially as described.

31. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks and casing-disks, said disks being corrugated facsimiles of each other, springs interposed between adjacent pairs of disks of the same set, and spacing-disks provided with a lubricating-channel, and means for pressing the disks together substantially as described.

32. In combination, a shaft, a casing adapted to contain a lubricant, shaft-disks, casing-disks, spacing-disks placed one between each shaft and casing disk, all aforesaid disks being corrugated and in respect to the corrugations facsimiles of each other, springs interposed between adjacent pairs of disks of the same set, and spacing-disks, provided with lubricating-channels formed by corrugating them, and placed one between pairs of disks of the same set, and means for pressing the disks together substantially as described.

33. In combination, a casing, shaft-disks, casing-disks and spacing-disks with means for

pressing the said disks together said spacing-disks providing channels for the passage of fluid, substantially as described.

34. In combination, a casing, clutch members comprising corrugated sheet-metal plates with a lubricant between the said plates, and means for controlling the pressure between the said clutch-plates, substantially as described.

35. In combination, a shaft, a casing, corrugated shaft-disks, corrugated casing-disks and corrugated disks interposed between the shaft-disks and casing-disks, all of said disks being facsimiles of each other as to their corrugations, and means for pressing the disks together, all of the said disks being formed of thin sheet metal, substantially as described.

36. In combination, a shaft, a casing, corrugated shaft-disks, corrugated casing-disks and corrugated disks interposed between the shaft-disks and casing-disks, all of said disks being facsimiles of each other as to their corrugations, and means for pressing the disks together, said interposed disks being of softer material than the shaft and casing disks, all of the said disks being formed of thin sheet metal substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

HENRY SELBY HELE-SHAW.

Witnesses:

J. E. LLOYD BARNES,  
JOSEPH E. HIRST.