

Dec. 5, 1939.

L. A. ELMER

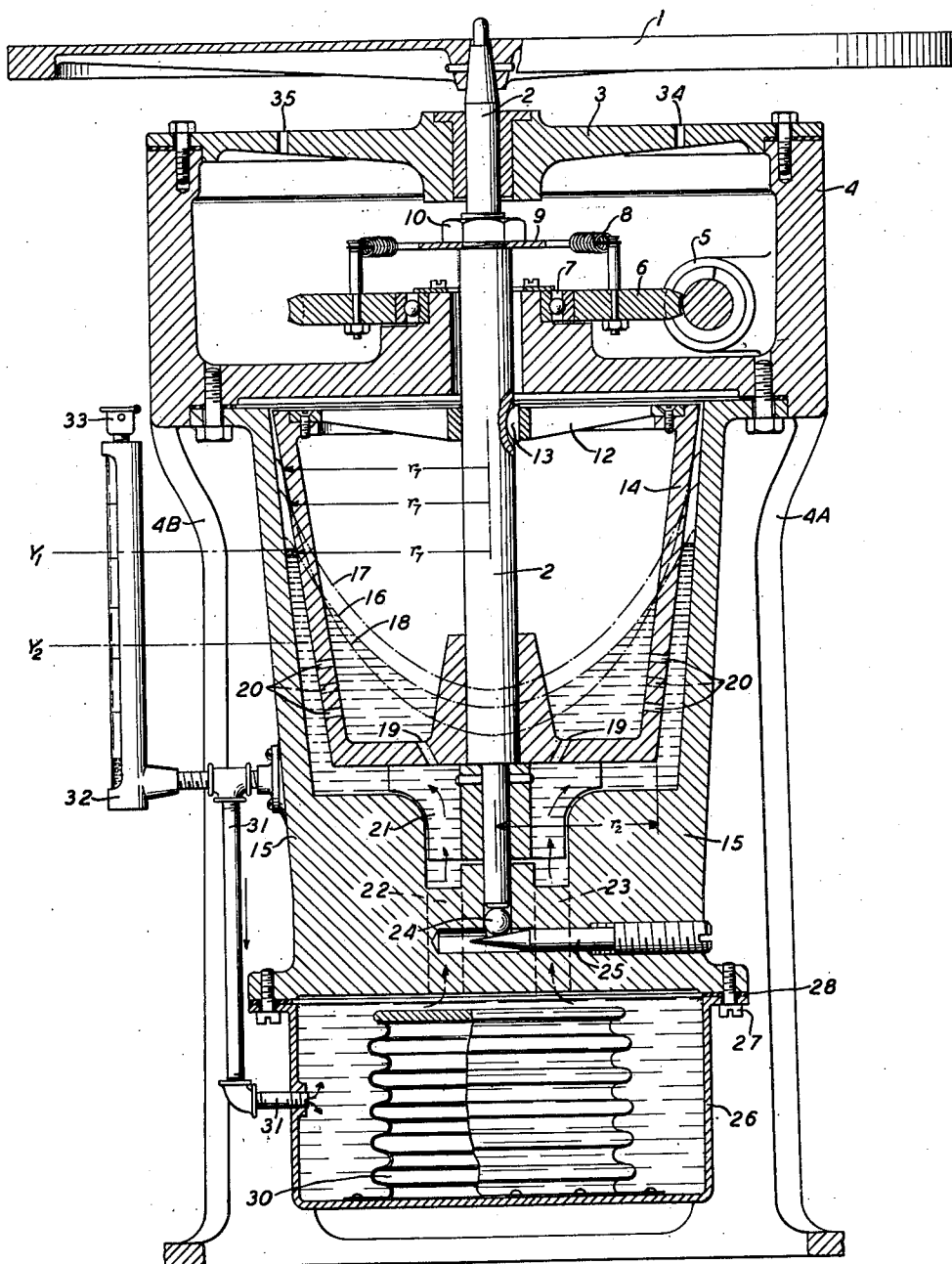
2,182,076

VISCOUS DAMPENER

Filed Aug. 31, 1937

3 Sheets-Sheet 1

FIG. 1



INVENTOR
L.A. ELMER

BY *G.H. Heydt.*
ATTORNEY

Dec. 5, 1939.

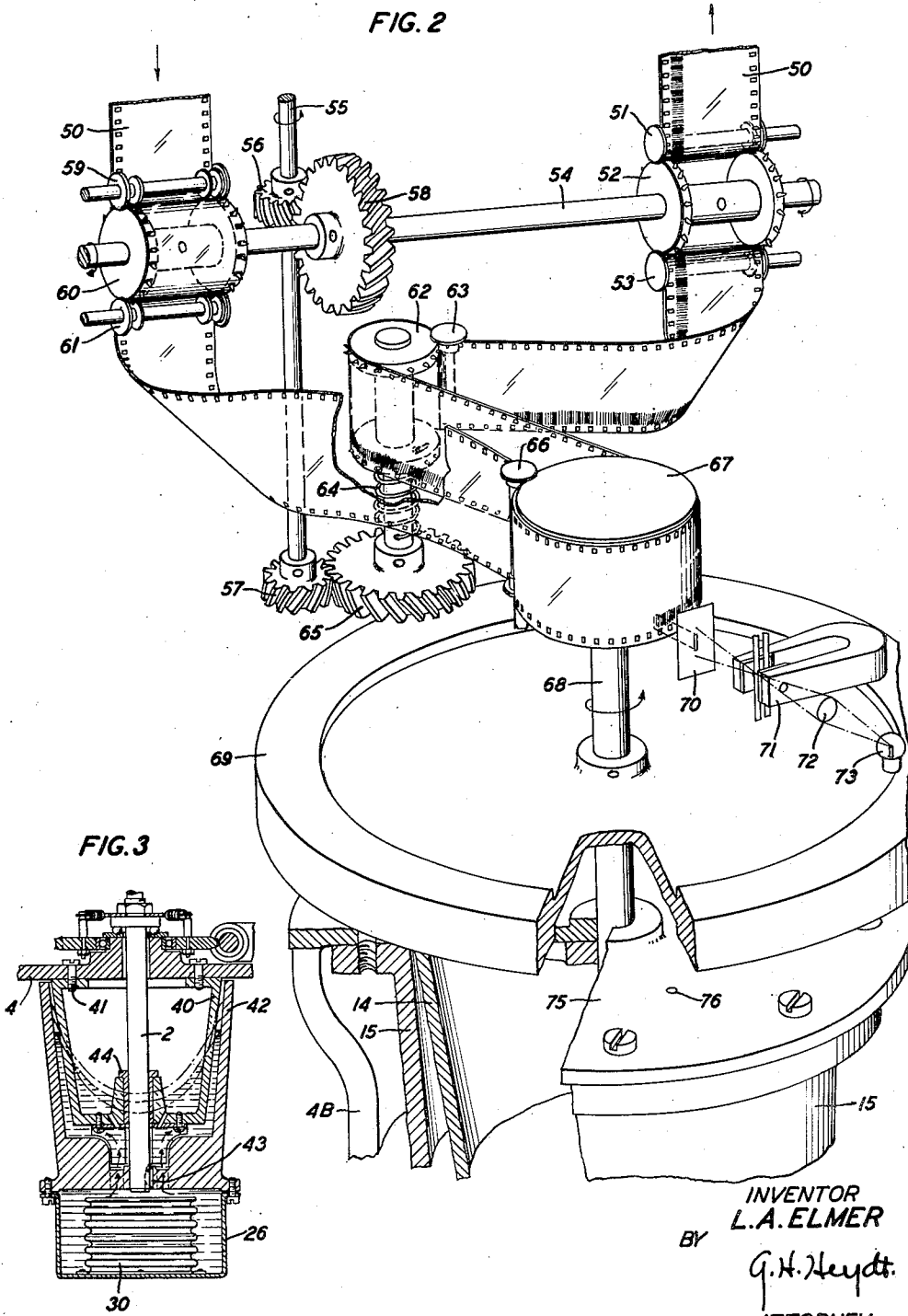
L. A. ELMER
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FIG. 2



INVENTOR
L. A. ELMER
BY
G. H. Heydt.
ATTORNEY

Dec. 5, 1939.

L. A. ELMER

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VISCOUS DAMPENER

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FIG. 6

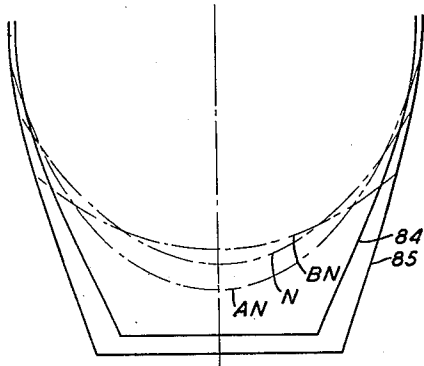


FIG. 5

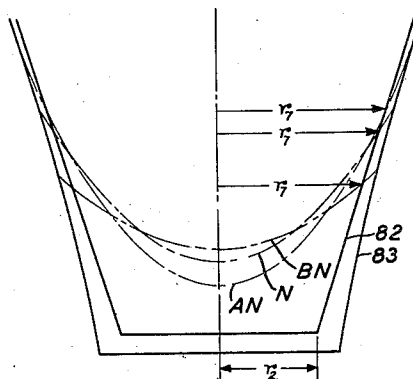


FIG. 4

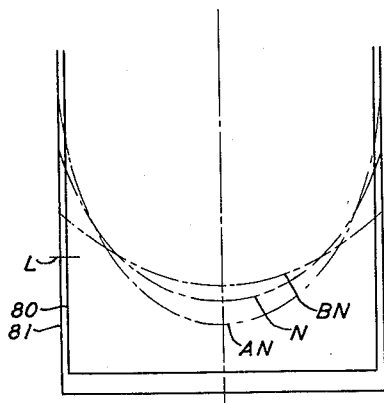
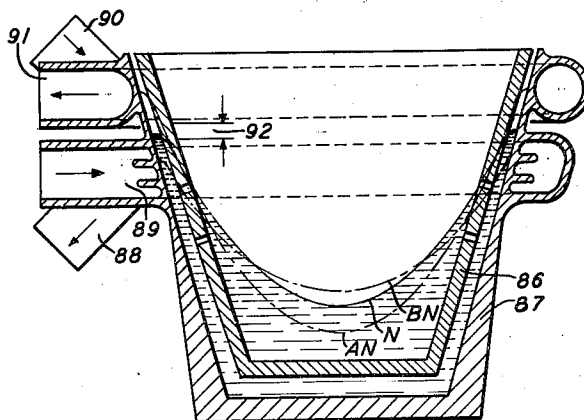


FIG. 7



INVENTOR
L.A. ELMER

BY *G.H. Seydt.*
ATTORNEY

UNITED STATES PATENT OFFICE

2,182,076

VISCOUS DAMPENER

Lloyd A. Elmer, Short Hills, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application August 31, 1937, Serial No. 161,756

11 Claims. (Cl. 188—90)

This invention relates to a viscous dampener for resisting momentary deviations in velocity of a driven member for producing uniform velocity.

5 This invention is particularly useful in combination with moving or driven mechanisms of small mass, whose velocity may be momentarily varied by imperfections in gears and bearings or by variations in load. A true example of a
10 structure of this character is presented in sound picture apparatus and, therefore, the dampener according to the invention may be suitably applied to this apparatus. In sound picture apparatus in which the sound and scene are simulta-
15 neously translated, it is common practice to drive the sound and the picture translating apparatus from a common source of power to insure synchronous translation. In apparatus of this general character the picture record is intermittently
20 moved but translated when it is not in motion, while the accompanying sound effects are recorded or reproduced with the record carrying medium in continuous motion. The movement of this record carrying medium must be con-
25 trolled as to uniformity, to an extent which prevents the intrusion of velocity variations which cause noticeable soundpitch variations.

A representative application of a viscous dampener to sound picture apparatus is disclosed in
30 Patent 1,962,367, issued to E. H. Smythe, June 12, 1934. In this patent the dampener is shown in combination with an elastic member as a resistance terminated filter for suppressing variations affecting the velocity of the sound
35 sprocket. In the known dampeners of this type the resistance between dampening member surface is proportional to velocity but a swamping resistance is created at normal speed which resistance must be sufficient to dampen velocity
40 variations at the normal running speed and above normal running speed. This requires a dampener of considerable size which in some cases is out of proportion to the associated mechanism including the motor which would ordinarily be used
45 for driving the mechanism, since, in such devices, a high resistance load or torque in the region of normal velocity is required to obtain a comparatively large change in resistance torque from a small change in velocity.

50 The object of the present invention is, therefore, to provide a highly efficient centrifugal dampener of convenient dimensions, having a low torque during starting, a comparatively low torque during normal running speed and a high
55 ratio of change in torque to change in speed

for small variations at and near normal running speed to quickly suppress momentary velocity variations caused by variations in the gears, bearings and load during the operation of mechanism at said normal running speed.

5 In carrying out the object of the invention, a self-regulating centrifugal viscous resistance element is provided comprising two cup-shaped members having a viscous resistance formed between opposing surfaces. The invention contem-
10 plates that one of the cup-shaped members, either the outer or the inner may be rotated while the other is maintained stationary. A quantity of viscous fluid is placed in the cup-shaped members in such relation to the opposing
15 walls that during the starting of the machine only a small area of the opposing surfaces have liquid therebetween and consequently very little resistance is created between these opposing surfaces. As the rotating cup-member and the driving
20 motor come up to normal running speed, the level of the viscous fluid is raised at the outer edges by centrifugal force and the fluid takes the form of parabola which materially increases the area of opposing surfaces having viscous fluid
25 therebetween and brings the resistance up to the correct value for normal velocity. This value is comparatively low since as hereinafter set forth, it is quickly altered by raising and lowering the fluid by centrifugal force. At normal running
30 speed the fluid remains in a particular parabolic formation. In the simplest form of the dampener a momentary increase in velocity raises the outer portion of the fluid between the opposing surfaces of the dampener cups, which increases the effective surface area and creates a sudden increase
35 in resistance. During a decrease in velocity there is conversely a decrease in surface area and a decrease in resistance between opposing walls.

40 Various degrees of effectiveness in dampening may be provided with the centrifugal viscous dampener of the invention depending upon requirements of the particular devices to which it is applied. The simplest form of this dampener having straight side walls an equal distance apart
45 provides only an increase or decrease in resistance surface area during momentary changes in velocity above or below normal velocity. In other dampeners with slanting walls a compounded or
50 higher power ratio of change in resistance over change in velocity is created by a graded change in circumference and a graded change in radius of action which greatly increases effectiveness in rapidly suppressing velocity variations. This may
55 be further amplified by a graded change in the

distance between opposing resistance surfaces which approach each other as the diameter of the cups becomes greater and by external heating and cooling coils associated with the dampener in particular locations.

It is recognized that one of the major difficulties in the use of viscous resistance elements resides in the inherent disadvantage of changes in viscosity due to changes in temperature. The present invention contemplates the use of an automatic adjusting member in the form of an air chamber immersed in the viscous liquid for raising or lowering the level of the liquid in the cups according to temperature changes. The range of ratios of resistance to speed is thus maintained the same under all conditions of viscosity. It is well known that commercial oils change their viscosity in the ratio of about five to one as their temperature is raised from 60° F. to 100° F. which are the usual temperatures in which apparatus is required to operate. By the use of an air chamber, the restriction ordinarily imposed upon viscous dampeners is removed since the expansion and contraction of the air chamber may be calculated for a dampener according to this invention, to exactly compensate for changes in viscosity of the fluid due to temperature changes.

One specific embodiment contemplates the use of the dampener according to this invention in combination with disc recorders and reproducers which may be coupled with picture recording and reproducing devices according to arrangements well known in the art.

Another specific embodiment contemplates the use of the dampener accorded to this invention in sound recorders for recording sound on film which may be synchronized with picture recording units.

In the illustrated embodiment Fig. 1 illustrates a dampener according to the invention associated with sound recorders or reproducers having a turntable for disc records.

Fig. 2 illustrates a dampener according to the invention associated with a sound film recorder.

Figs. 3 to 7 illustrate various forms of the dampener, all of which are basically of the same type but include specific modifications.

The turntable sound unit illustrated in Fig. 1 may be used in combination with motion picture machines such as are in general use. An arrangement of this character is disclosed in Patent 1,847,181 to H. C. Harrison, March 1, 1932. The worm 5 of Fig. 1 is driven by a motor arranged as shown in the foregoing patent, which motor may also drive the motion picture unit. The worm wheel 6 driven by the worm 5 rotates on ball bearings 7 and drives the shaft 2 and the turntable 1 mounted thereon, through the flexible springs 8 and the spider 9. The spider 9 is mounted on the shaft 2 as shown, and clamped in place by nut 10. The shaft 2 is journaled in the housing plate 3 and in the dampener housing 15. The lower extremity of shaft 2 is mounted on a ball 24 which rests upon an adjusting pin 25. The housing 3 is mounted upon the gear housing 4 and framework 4A and 4B, which extends to a supporting member.

The dampener comprises a stationary cup-shaped housing 15 filled with a viscous fluid to a particular level suitably bolted to the gear housing 4, and a rotatable cup-shaped member 14 which is fastened to shaft 2 by key 13. The dampener of Fig. 1 as shown has a graded change in circumference, a graded change in radius of action and a graded change in distance between opposing resistance surfaces but may take the

forms shown in Fig. 3, 4, 5, 6 or 7. Below the housing 15 is mounted a fluid reservoir 26 having a fluid level controlling air chamber 30 therein. The air chamber 30 is made in a manner to expand and contract as the temperature of the fluid changes and is preferably in the form of a sealed siphon bellows. A fluid rotating system is included for assisting in the production of rapid pressure changes when a change in velocity takes place. This comprises a member 21 pinned to the shaft 2 having external vanes for rotating the fluid.

Since the cup-shaped dampening member 14 is keyed to the shaft 2, its rotation is controlled by the worm 5 the same as the turntable 1. The dampener thus effects a direct control of velocity variations reflected to the turntable. The cup-shaped housings 14 and 15 and the reservoir 26 are filled with a viscous fluid to a particular level which is calculated according to the position taken by the fluid at normal speed, as explained later. A filler cup 33 is provided for placing the viscous fluid in the dampener housings and a gauge 32 is provided for indicating the level of the fluid. In order to have the correct quantity of fluid for the necessary regulation required the rotatable cup is used as part of the reservoir, the fluid entering and leaving through ducts 19 and 20 according to variations in velocity and temperature. The parabolic curve 16 indicates the fluid level at normal speed and normal temperature. The parabolic curve 17 indicates the fluid level at normal speed with the fluid above normal temperature. The parabolic curve 18 indicates the fluid level at an overspeed of the dampener. The parabolic curve is not shown for a speed under normal but would be similar to the normal speed curve 16 with the center raised and the upper ends lowered and flattened out. Due to the graded difference in space from the bottom to the top of the outer wall of dampener cup 14 and the inner wall of dampener housing 15 the dampening resistance rapidly increases from bottom to top in what may be expressed as a compounded ratio or higher order function ratio of drag and speed. For the sake of clarity, the distance between opposing surfaces are shown enlarged, for example, these distances may be approximately twenty thousandths of an inch at the bottom and six thousandths of an inch or less at the top. The dampener rotating at normal speed produces a given resistance with the viscous fluid level at the level indicated for normal speed and normal temperature. This level is at a point where a momentary thrust or increase in speed of the dampener raises the fluid into the zone where the walls or surfaces are rapidly approaching one another. The rise in the fluid not only increases the effective resistance creating surface area but increases the resistance to motion or drag at a compounded or higher power ratio. The power of the ratio increase depends upon the degree of approach of the walls with increasing level of the fluid. This increase is always higher than the first power of cup velocity. The reverse effect is produced when the speed is momentarily decreased. In this case the fluid drops suddenly to a wider space between the walls which reduces the effective resistance creating surface area and also reduces the resistance to motion at a compounded or higher power ratio. In each case the increase or decrease in resistance is greatly out of proportion with the increase or decrease in speed, insuring an extremely rapid acting mechanical

filter or dampener which is of much greater efficiency in absorbing velocity variations than viscous dampeners which vary directly in proportion to velocity.

The difficulty from changes in viscosity due to temperature changes is eliminated by the introduction of device 30 which compensates for such changes. If the temperature of the fluid rises, the air within the chamber 30 is expanded, which causes the fluid to assume a higher level between dampener walls compensating for the decrease in viscosity. The size of the air chamber is made such that an accurate compensation is made for an increase or decrease in viscosity of the fluid at lower or higher temperatures to maintain the set values of resistances throughout the range of operation at different temperatures.

An adaptation of the dampener according to the invention has been shown in Fig. 2 embodied in a film sound recording unit. It is well known that a major difficulty in using a viscous dampener with film recorders is due particularly to the fact that the sound sprocket is placed on a horizontal shaft. In the present adaptation a vertical sprocket and vertical sound recording roller are used. The sound recording roller 67, the flywheel 69 and the viscous dampener are fastened to shaft 68 and driven by the film 50. In this case the dampener is the same as previously described with the exception that a cover plate 75 having breather holes 76 therein is fastened to the dampener housing 15. The shaft 68 within the dampener is of the same construction as shaft 2. Shaft 68 is journaled in the cover plate 75.

Three sprockets 60, 62 and 52 are incorporated in this sound unit and driven by a common gear set as shown. The shaft 55 having gears 56 and 57 thereon is a part of the usual mechanical transmission unit driven by an electric motor. The gear 56 is meshed with gear 58 for driving sprockets 52 and 60 and the gear 57 is meshed with gear 65 for driving sprocket 62 through the spring coupling 64. The film 50 is drawn into the sound recording unit by the pull-down sprocket 60 having guide rollers 59 and 61 associated therewith to retain the film in close contact with the sprocket teeth. From this point the film makes a right-angle turn and is drawn over roller 67 by the spring driven sprocket 62. Guide roller 66 is pressed against the roller 67 by a spring not shown, so that the film shall adhere closely to the surface of the roller. The usual guide roller 63 is associated with the vertical sprocket 62. As the film 50 leaves the sprocket 62 it again assumes a right-angle turn in order to be drawn upward by the horizontal hold-back sprocket 52 having guide rollers 51 and 53 associated therewith for maintaining the film in close contact with the sprocket teeth. A sound recording unit is diagrammatically shown comprising lamp 73, lens 72, valve 71 and slot unit 70.

The dampener illustrated in Fig. 3 is the same as Fig. 1 with the exception that the outer cup 42 is arranged to rotate and the inner cup 40 is stationary. In this embodiment the outer cup is rigidly fastened to shaft 2 by key 43 so that this cup and the reservoir 26 rotate with the shaft which in this case revolves in bearing 44 of the inner cup. The stationary inner cup is fastened to the housing 4 by screws 41.

Fig. 4 illustrates the advantages of the simplest form of a centrifugal dampener according to the invention having two cylindrical cup-shaped

members, as compared with other dampeners known in the art, such, for example, as the Smythe dampener shown in Patent 1,962,367, in which the resistance torque is proportional to the velocity of the rotating member. The centrifugal dampener of Fig. 4 with opposing walls 80 and 81 an equal distance apart provides a volume of viscous fluid in such relation to the walls that during the starting of the machine, only a small area of the opposing surfaces below point L has fluid therebetween and very little resistance is created between opposing surfaces. As the rotating member of the dampener and the driving motor come up to speed, the level of the viscous fluid is raised at the outer edges by centrifugal force and the fluid takes the form of a parabola. At normal running speed the fluid is in the form indicated by parabola N and the resistance has been increased in proportion to the increase in surface area having fluid therebetween. Above normal it is indicated by parabola AN, and below normal by parabola BN. A momentary increase or decrease in velocity above normal or below normal creates an increase or decrease in the surface area and resistance of the dampener. The simplest form of the dampener according to the invention therefore performs the functions of the dampener of the patent but with a lighter resistance load or drag at normal velocity which is made possible by the ability of this dampener to quickly increase the surface area and resistance torque at velocities above normal velocity. The dampener is therefore rapid in action and effective over a wide range of high or low frequency velocity variations, the resistance torque being momentarily increased or momentarily decreased an amount depending upon the variation.

A simple dampener according to the invention, Fig. 4, may be calculated from the following Formula No. 1:

$$Q = K\omega + K_1\omega^3 \quad (1)$$

in which

Q = resulting torque from the dampener.
 ω = angular velocity of the rotating cup.
 K = drag constant of proportionality.
 K_1 = constant depending on the dimensions of the cups and the viscosity of the fluid.

The improvement in effective damping action is carried to a high degree in the dampeners illustrated in Figs. 1, 3, 5, 6 and 7, in which the surface area is altered to a greater degree than in Fig. 4 by a graded change in circumference and a graded change in the radius of action. The efficiency of the dampener is further greatly amplified by a graded change in distance between opposing resistance surfaces which approach each other as the diameter of the cups becomes greater.

In view of the graduated space between opposing walls of the dampener, the torque required at normal velocity is only a small percentage of the torque required in the usual viscous dampener and therefore the power required to operate the dampener is in the same proportion. The comparatively wide space between opposing walls at the level of the liquid y_2 when the cup is stationary or when it is starting to rotate insures a light load on the motor during starting and during the period when the motor is coming up to normal speed which brings the liquid to level y_1 . The wider space below the normal speed level of the liquid y_1 insures very rapid action in the reduction of resistance when the liquid drops

below the normal level due to an overload upon the driving or driven members. The very narrow space between opposing walls above the normal velocity level of the liquid y_1 insures very rapid action by the great increase in resistance when the liquid is forced above the normal level in the case of a momentary decrease in load on the driving or driven members and in the case of imperfections in gears and bearings. The compounded or higher exponent ratio change in resistance over velocity as the liquid is moved from one level to another by a change in centrifugal force makes possible a much smaller resistance at normal velocity than required in other dampeners known in the art. The reason for this great difference is shown by the following Formula No. 2, which may be used as a general formula for the calculation of dampeners shown in the foregoing Figs. 1, 3, 5, 6 and 7 which may be modified for special conditions as explained later.

$$r_1 = \frac{gm}{3\omega^2} + \frac{gm}{3\omega^2} \sqrt{1 + \omega^2 B_1} - \frac{gm}{3\omega^2} \sqrt{2 - \omega^2 B_1 + \frac{2}{\sqrt{1 + \omega^2 B_1}}} \quad (2)$$

in which

$$B_1 = \frac{3}{gm^2} \sqrt{\frac{3m^2}{2}} A_1 \left[\sqrt{1 + \sqrt{1 - \omega^2 A_2}} + \sqrt{1 - \sqrt{1 - \omega^2 A_2}} \right]$$

in which

$$A_1 = \frac{m}{3} r_2^3 + \frac{v_2}{\pi} \text{ and } A_2 = \frac{13}{g^3 m^4} \left(\frac{m}{3} r_2^3 + \frac{v_2}{\pi} \right)$$

In the above formulae

r_1 = radius from axis of rotation to top edge of fluid.

g = acceleration of gravity.

m = slope of the cup walls.

ω = angular velocity of the rotating cup.

r_2 = short radius of cup as shown in Fig. 5.

v_2 = volume of liquid held by the cup at normal speed.

The volume of fluid required in the viscous dampener to obtain a given resistance at a normal running speed is computed by first assuming convenient dimensions for the dampener, such as dimensions r_2 and slope m for a particular r_1 as computed for obtaining a given resistance. The height of the cup wall is fixed by these dimensions and ω is fixed by the normal running speed which is usually known. The critical volume V_c is then calculated from the following Formula No. 3. The critical volume of fluid is that volume which would bring the parabolic surface of the liquid just tangent to the wall of the rotating cup at normal speed.

$$V_c = \pi \left[\frac{g^3 m^4}{12 \omega^3} - \frac{m}{3} r_2^3 \right] \quad (3)$$

Since critical volume is not desired, a volume less than this must be assumed for correct operation of the dampener. The value assumed may be 90 per cent or 95 per cent of the critical volume which is given as V_n or normal volume in the following Formula No. 4. This formula is given for the purpose of obtaining the correct fluid level when the cup is not rotating.

$$y_2 = m \left[\sqrt{\frac{3V_n}{\pi m} + r_2^3} - r_2 \right] \quad (4)$$

In which y_2 is the height of the stationary fluid above the bottom of the rotatable cup.

The following Formula No. 5 using the maxi-

mum radius calculations of Formula 2 is given to exemplify the effectiveness of a dampener according to Figs. 1 and 3. The torque from the side walls of the dampener is shown as T_3 .

$$T_3 = \frac{2\pi\mu\sqrt{m^2+1}}{d_1} (r_m - r_2)\omega \left[r_m^3 \log_e (r_m - r_2) - r_m^3 \log_e (r_m - r_1) - r_m^3 (r_1 - r_2) \right. \\ \left. - \frac{r_m^2 (r_1^2 - r_2^2)}{2} - \frac{1}{3} (r_1^3 - r_2^3) \right] \quad (5)$$

In the above formula

μ = the viscosity of the fluid in the dampener.

ω = the angular velocity of the rotor.

r_m = the radius from the axis of rotation to the point where the walls of the inner and outer cups would intersect if produced.

r_2 = the radius to the bottom corner of the cup as shown in Fig. 1.

r_1 = the radius from the axis of rotation to the top edge of the fluid.

d_1 = the separation of the walls at the same level as r_2 .

m = the slope of the side walls of the inner cup.

Fig. 5 illustrates a dampener having the wall of the rotating cup straight and the opposing wall of the stationary cup approaching the wall of the rotating cup as a curve. A dampener of this type has the advantage of simplicity in calculation. This Formula No. 6 is based on Formula No. 2 but differs from Formula No. 5 since it does not include logarithmic terms and only uses a fifth power. This dampener is, however, slightly less efficient than those with the straight opposing side walls which approach each other as shown in Figs. 1 and 3. The torque from the side walls of this dampener is given as T_5 .

$$T_5 = \frac{2\pi\mu\sqrt{m^2+1}}{5C_1} \omega (r_1^5 - r_2^5) \quad (6)$$

In which

C_1 = a constant depending on the separation of the side walls at radius r_1 and also on radius r_2 .

μ = the viscosity of the fluid in the dampener.

m = the slope of the side wall of the inner cup.

ω = the angular velocity of the rotor.

r_1 = the radius from the axis of rotation to the top edge of the fluid.

r_2 = the radius to the bottom corner of the cup as shown in Fig. 5.

The efficiency of the dampener Fig. 5 may be made higher by increasing the rate of approach of the side walls above that shown by Formula 6.

The dampener of Fig. 6 may be calculated from formulae developed in a manner similar to those for Figs. 1 and 3. This dampener is designed for a larger range of operating speeds, the side walls being brought toward each other at the top to extend the range of operation above the critical speeds of the other embodiments of this drive.

The dampener illustrated in Fig. 7 carries out the same idea as illustrated in Fig. 1 with the exception that it is made extremely quick acting for increasing or decreasing resistance values by introducing a flow of hot water at a point just below the fluid level assumed at normal running speed and a flow of cold water just above this level. A dampener of this character is useful in mechanism where an extremely light normal resistance drag is required with a large resistance change for a small velocity change. The hot

water is shown entering the orifice 89 to flow in an anti-clockwise direction around a stationary wall 87 of the dampener and flowing out of the orifice 88. The cold water is shown entering orifice 90 to flow around the dampener in a clockwise direction and flow out of orifice 91. The purpose of regulating the flow of water in opposite directions is to create a substantially constant temperature difference throughout the entire periphery of the dampener. A dampener of this character may be made very effective by choosing a temperature for the cold water near the gelable temperature of the liquid or possibly more practical, choosing an oil that is gelable slightly below the temperature of a brine or cold water. It will be noted that the normal operating level of the fluid is shown midway between the hot and cold channels. The metallic wall of the stationary cup between these two channels is made thin to reduce the quantity of circulating water required. This portion 92 of the outer cup wall, therefore, has a high temperature gradient cold above and hot below the normal operating level. As the speed of inner cup 86 increases, the viscous fluid comes into contact with a cold region and its viscosity increases rapidly giving an extremely high torque from a very narrow band of oil between opposing surfaces of the cups. If the cup velocity decreases the band of oil heats rapidly and greatly reduces the resistance. The viscous fluid in the upper region of the dampener would be less affected by changes in ambient temperatures and consequently the air chamber in the bottom of the dampener can be made much smaller.

The hot and cold water respectively, are circulated from and to suitable reservoirs by means of continuously acting pumps. If desired the temperatures may be maintained within a desired range by means of well-known temperature regulating mechanisms.

It is not the intention to limit the use of the dampener according to the invention in the specific manner disclosed, since it is applicable to many types of mechanisms in which uniform motion is required.

What is claimed is:

1. A viscous resistance dampener for suppressing momentary deviations from a sustained uniform velocity of a rotating member, said dampener including nested rotating and stationary cup-shaped members one within the other, damping fluid in engagement with both inner and outer walls of said inner cup-shaped member, and means for altering the effective surface area of the dampener responsive to velocity variations.

2. A variable viscous resistance dampener comprising a viscous fluid and a moving member in proximity to a stationary member, said members being nested one within the other with said viscous fluid in engagement with both inner and outer walls of the inner member, the contour of said members and the relation of said fluid thereto providing means to vary the effective surface area of the dampener responsive to any variation in velocity of said moving member.

3. A variable viscous resistance dampener comprising a viscous fluid and a rotating member in proximity to a stationary member, said members being nested one within the other with said viscous fluid in engagement with both inner and outer walls of the inner member, the contour of said members and the relation of the fluid thereto providing means to vary the surface area of the

resistance dampener by variations in centrifugal force responsive to any variations in velocity of the rotating member.

4. A variable viscous resistance dampener comprising a stationary cup-shaped member and a rotatable cup-shaped member with proximate opposing surfaces, means for driving said rotatable member, a viscous fluid within said members in such relation to said opposing surfaces that a negligible resistance is created at starting velocities and a comparatively large resistance is created at normal running velocity.

5. A viscous resistance dampener comprising a viscous fluid, a rotatable member and a stationary member, said members being nested one within the other with said viscous fluid in engagement with both inner and outer walls of the inner member, and means influenced by the contour of said members for creating a low resistance at low speeds and a higher resistance at higher speeds by altering by centrifugal force the effective surface area of the dampener.

6. A viscous resistance dampener for adding a damping load to resist velocity variations in a driven mechanism comprising a viscous fluid and a rotating member adjacent to a stationary member with the wall of the rotating member and the wall of the stationary member slanting toward each other, arranged to cause said viscous fluid by centrifugal force to assume a particular level between said walls at normal velocity for creating a normal resistance load and for compounding the ratio of change in resistance over velocity change as the level of the fluid is varied by variations in velocity by raising the fluid between narrowing walls to increase the resistance at a compounded ratio responsive to a momentary increase in velocity and by lowering the fluid to a point where the walls are a greater distance apart to decrease the resistance at a compounded ratio responsive to a momentary decrease in the velocity, and means to compensate for viscosity variations in the fluid due to heat variations.

7. A viscous dampener for adding a damping load to resist velocity variations in a driven mechanism comprising a viscous fluid, a stationary cup-shaped member forming one resistance member of said dampener, a rotating cup-shaped member having its wall slanting toward the wall of said stationary member, one member being within the other with a minimum space between the upper extremity of the rotating wall and the stationary wall, said members forming a reservoir for the fluid, the inner cup having ducts through which the fluid passes inward by gravity and outward by the action of centrifugal force, and means to rotate said cup with said driven mechanism to cause said viscous fluid by centrifugal force to assume levels between said outer and inner walls which provides a set value of resistance at normal velocity and an exponentially progressive ratio of change in resistance over change in velocity, the exponent of said ratio being greater than one.

8. A viscous dampener for adding a damping load to resist velocity variations in a driven mechanism comprising a viscous fluid, a stationary member forming one resistance member of said dampener, a rotating member having its wall slanting toward the wall of said stationary member, said members forming a reservoir for the fluid, one member having ducts through which the fluid passes in one direction by gravity and the other direction by the action of centrifugal force, means to rotate said member with said

driven mechanism to cause said viscous fluid by centrifugal force to assume levels between said walls which provides a set value of resistance at normal velocity and an exponentially progressive ratio of change in resistance value over velocity change, the exponent of said ratio being greater than one for values either above or below normal resistance and velocity, and thermal responsive means to compensate for viscosity variations for maintaining said values under differing temperature conditions.

9. A viscous resistance dampener comprising opposing surfaces having a viscous fluid therebetween for creating resistance torque and means associated with certain localized areas of one of said circular surfaces for altering the viscosity of said fluid.

10. A viscous dampener arranged to rotate for adding a dampening load to resist velocity variations in a driven mechanism, comprising a fluid having a thermal viscosity, a rotating member, and a stationary member nested one within the

other, whereby the fluid is driven between said members to a particular level by centrifugal force at normal velocity for creating a normal resistance and above and below said normal level by higher and lower velocities for creating higher and lower resistance to suppress velocity variations, and a heating coil above the normal level, and a cooling coil below the normal level for rapidly altering the viscosity of the fluid to create a rapid change in resistance for suppressing said velocity variations.

11. A viscous resistance dampener for suppressing momentary deviations from a sustained uniform velocity of a rotating member, said dampener including nested rotating and stationary cup-shaped members one within the other, damping fluid in engagement with both inner and outer walls of said inner cup-shaped member, and ducts in the walls of said inner cup-shaped member permitting passage of said damping fluid therethrough.

LLOYD A. ELMER.