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Jorgensen

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[54] **LUBRICATION SYSTEM FOR GEAR DRIVE MECHANISMS**

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[52] **U.S. Cl.** **184/6.2,** 184/6.12, 212/68

[51] **Int. Cl.** **F01m 11/06**

[58] **Field of Search** ..... 184/6.2, 6.12; 212/67, 212/68; 74/606 R, 467

[56] **References Cited**

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Attorney, Agent, or Firm—Phillips, Moore, Weissenberger, Lempio & Strabala

[57] **ABSTRACT**

An excavator comprises an upper unit rotatably mounted on an undercarriage by selectively driving a swing pinion against a reaction ring gear secured to the undercarriage. An enclosure forms an annular chamber containing the swing pinion and ring gear therein. An annular tray is disposed in the chamber and has radially disposed and separated compartments for assuring uniform and efficient distribution of lubricating oil therearound when the excavator is tilted relative to ground level. The bottom walls of the enclosure and tray each comprise generally V-shaped bottom walls to aid in such distribution of the lubricating oil.

8 Claims, 8 Drawing Figures

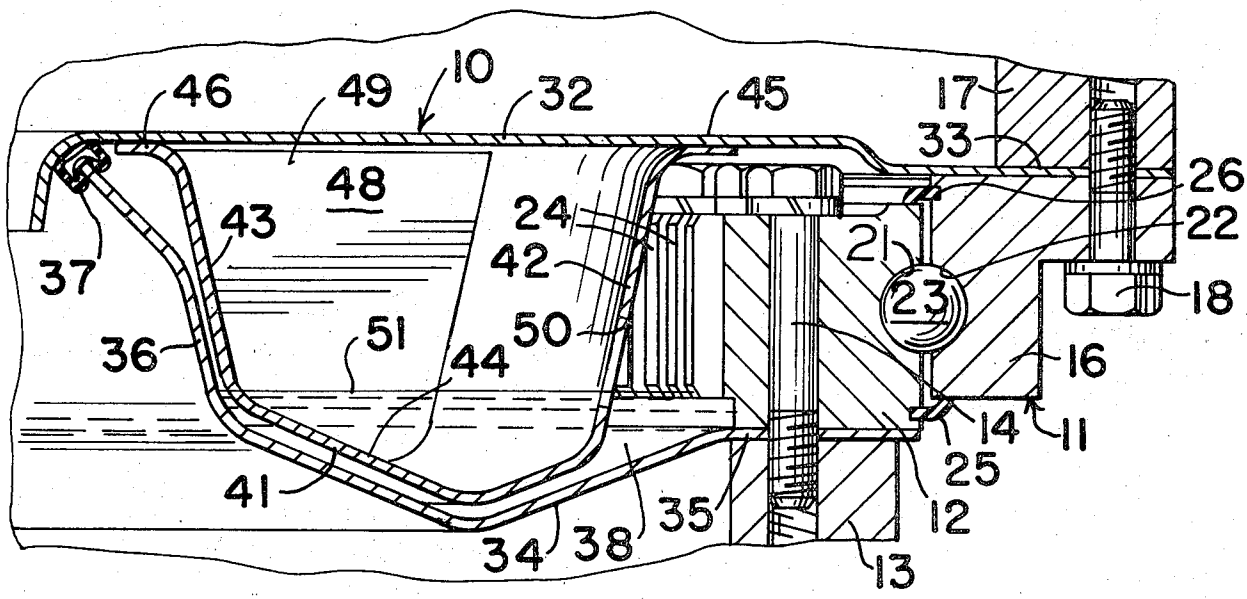

Fig. 1

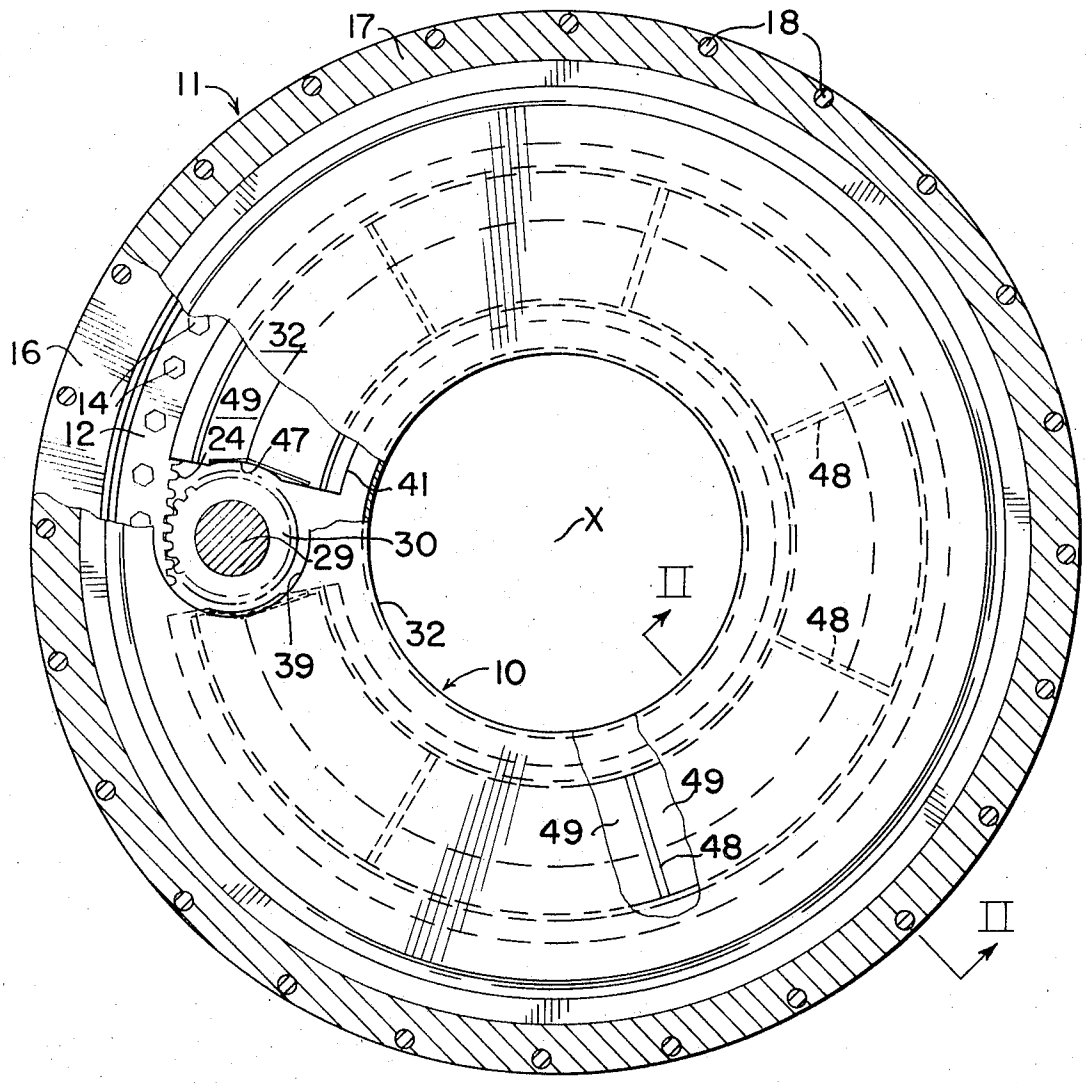

Fig. 2

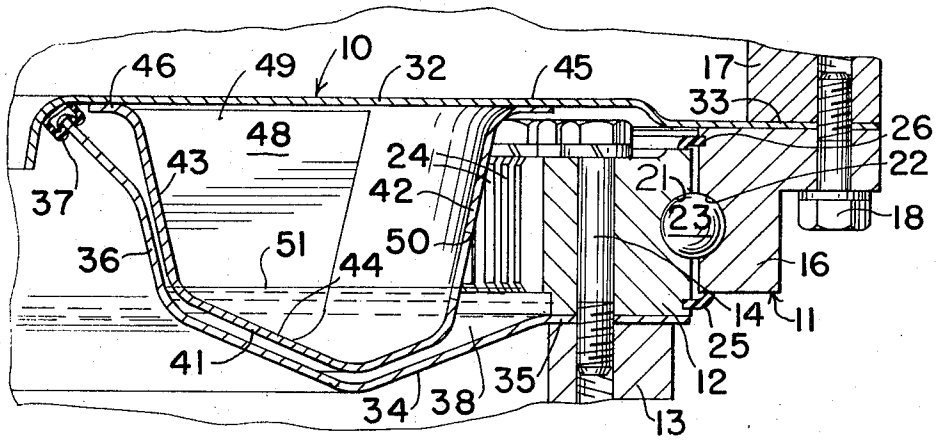
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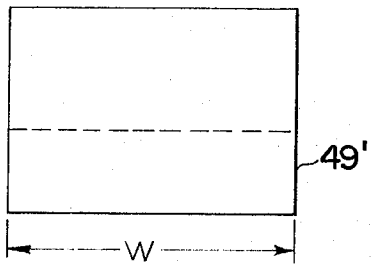
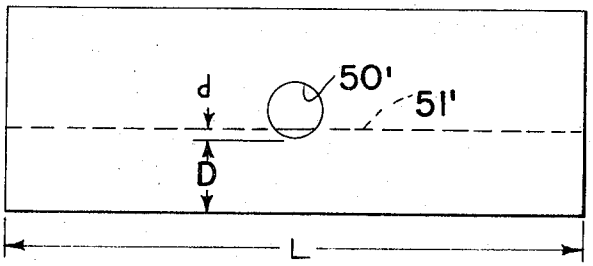
Fig. 3



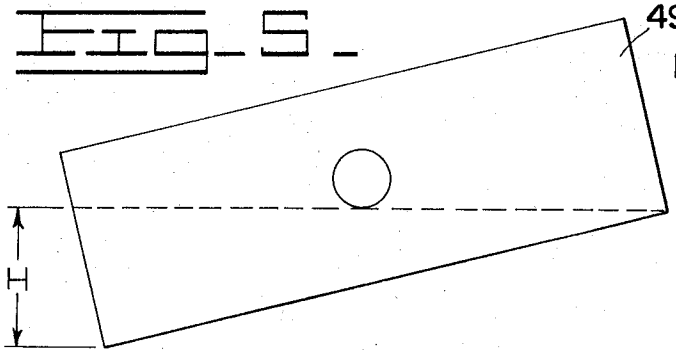
PRIOR ART

Fig. 4



PRIOR ART

Fig. 5



PRIOR ART

Fig. 6

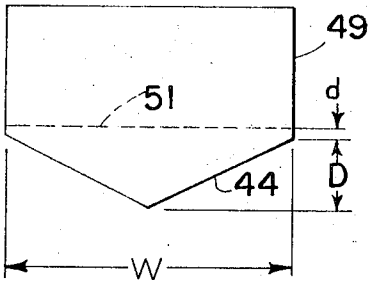


Fig. 7

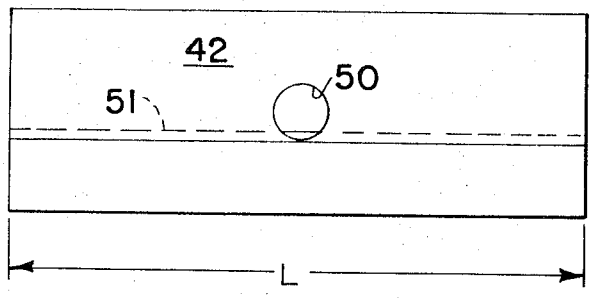
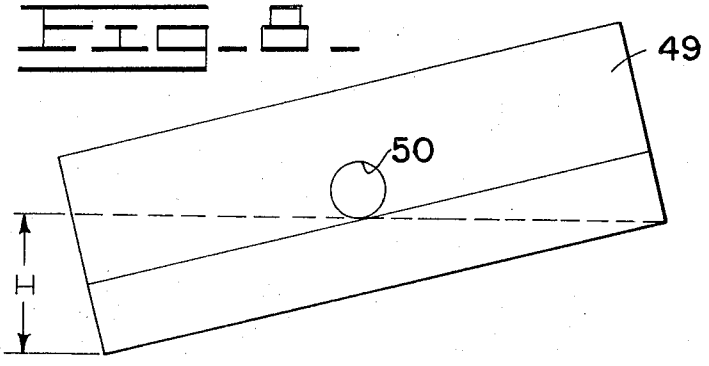


Fig. 8



LUBRICATION SYSTEM FOR GEAR DRIVE MECHANISMS

BACKGROUND OF THE INVENTION

The present invention relates to a lubrication system for continuously lubricating a gear drive mechanism, particularly adapted for use in a hydraulic excavator. Conventional power transmissions employed in excavators include a motor-driven swing pinion which rotates against a stationary ring gear to selectively rotate an upper unit relative to a mobile undercarriage.

The swing pinion and associated ring gear are generally open to ambient to thus expose them to dust and other foreign matters associated with the operation of the excavator. The swing pinion and ring gear are usually lubricated by applying a heavy grease thereto. The grease tends to entrap such dust and foreign matters to abrasively wear the gears unduly.

Various systems have been proposed to continously supply lubricating oil to the pinion and ring gear during all phases of excavator operation. Some of these prior art systems are described in the preamble to U.S. Pat. application Ser. No. 238,311, now Pat. No. 3,811,577, filed on Mar. 27, 1972 by John W. Yancey for "Enclosed Gear Drive Mechanism for Excavators". Such application, assigned to the assignee of this application, discloses a solution to the lubricating problems outlined therein.

OBJECTS OF THE INVENTION

An object of this invention is to provide an improved and efficient lubrication system for a gear drive mechanism which is adapted to continuously lubricate the mechanism during all operational phases thereof, and particularly when an enclosure therefor is tilted relative to ground level. The lubricating means includes an annular tray, disposed in the enclosure, comprising contiguous sidewalls and a downwardly pointing bottom wall generally having a V-shaped cross section.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects of this invention will become apparent from the following description and accompanying drawings wherein:

FIG. 1 is a top plan view in section disclosing an enclosed gear drive mechanism and lubrication system for a hydraulic excavator, with portions broken-away for clarification purposes;

FIG. 2 is an enlarged sectional view, taken in the direction of arrows II—II in FIG. 1; and

FIGS. 3–8 schematically compare the operations of a conventional lubrication system (FIGS. 3–5) and the lubrication system of this invention (FIGS. 6–8).

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, an enclosure 10 is shown in association with a swing bearing 11 for an excavator. The swing bearing includes an inner ring member 12 secured to an underlying support ring 13 of a mobile undercarriage (not shown) by a plurality of circumferentially disposed bolts 14. The inner ring member is concentrically disposed about a vertically disposed central axis X thereof and within an outer ring member 16 attached to a mounting ring 17 of a rotatable upper unit (not shown) by a plurality of bolts 18.

The inner and outer ring members are formed with complementary raceways 21 and 22 (FIG. 2), respectively, which mount a plurality of circumferentially disposed ball bearings 23 therebetween to permit the ring members to rotate relative to each other, about common axis X. The inner ring member has a reaction-type ring gear formed thereon including a plurality of gear teeth 24 positioned to face radially inwardly towards such axis. Annular lip seals 25 and 26 are secured to the inner and outer ring members, respectively, and are maintained in sliding and sealing contact with the inner ring member.

The seals cooperate to retain bearing grease in the enclosure and to prevent the ingress of dust and other foreign abrasive matter into the raceways for the bearings. A power transmission, not shown, is fixedly mounted on the upper unit to selectively rotate mounting ring 17 relative to underlying support ring 13 in the usual manner. The transmission drives a vertically disposed swing or output shaft 29 (FIG. 1) having a swing pinion 30 attached on the lower end thereof. The swing pinion is selectively driven against the relatively stationary ring gear to provide a gear drive mechanism for effecting rotation of the upper unit relative to the undercarriage.

As best shown in FIG. 2, enclosure 10 includes a horizontally disposed and annular upper wall 32 which extends radially inwardly from swing bearing 11. The upper wall has a flat, outer flange 33 sealingly secured between outer ring member 16 of the swing bearing and mounting ring 17. A horizontally disposed and annular lower wall 34 is spaced vertically below the upper wall and has an outer flange 35 sealingly secured between inner ring member 12 and support ring 13.

The lower wall 34 extends radially inwardly from swing bearing 11 and has a generally V-shaped cross section. An upwardly extending inner sidewall 36 of the enclosure is disposed generally vertically between the upper and lower walls 32 and 34 and is concentric with respect to the swing bearing. A standard liquid gasket compound, not shown, may be preapplied to both sides of flanges 33 and 35 prior to the final assembly of the upper and lower walls to provide a leakproof seal thereat.

An annular seal 37 is secured to an upper edge of sidewall 36 to sealingly engage upper wall 32. Seal 37, along with seal 26, provides annular sealing means for effecting fluid tight seals thereat. Such sealing means thus fully seals an annular chamber 38, defined in the enclosure by walls 32, 34 and 36 and the toothed side of inner ring member 12.

As shown in FIG. 1, an aperture 39 is formed through upper wall 32 to permit the swing pinion 30 to extend therethrough and into chamber 38. A substantially annular tray 41 is disposed in the chamber and is spaced slightly apart from the walls forming same. The tray comprises a pair of radially spaced sidewalls 42 and 43 extending generally vertically upwardly from a generally horizontally disposed and contiguous bottom wall 44. The bottom wall has a generally V-shaped cross section and points downwardly to have its apex disposed substantially below the ring gear.

Upper ends of sidewalls 42 and 43 terminate at flanges 45 and 46, respectively, secured by welds or the like to upper wall 32 of the enclosure. The tray is interrupted circumferentially to define an opening 47 (FIG. 1), aligned with aperture 39 formed in the upper wall

of the enclosure to accommodate pinion **30** therein. A plurality of circumferentially spaced baffle plates **48** are secured within the tray to extend radially between sidewalls **42** and **43** to divide the tray into a plurality of individual compartments **49**. Sidewall **42** has a plurality of circumferentially spaced ports **50** formed therethrough, adjacent to bottom wall **44** and to the ring gear, to communicate each compartment with annular chamber **38**.

When the vehicle is maintained substantially level, chamber **38** and compartments **49** may be charged with lubricating oil in the usual manner whereby the oil will seek a common level **51** (FIGS. **2** and **7**). When swing pinion **30** is rotated to cause it to orbit internally of the ring gear, lubricating oil will splash onto the meshing gear teeth to fully and continuously lubricate such teeth during usage.

Upon tilting of the vehicle from its level position, such as during a sidehill operation, compartments **49** will function to maintain a fairly uniform distribution of the lubricating oil around chamber **38**. The compartments maintained on the high side of the lubrication system will trap and retain a substantial portion of the lubricating oil originally contained therein when the vehicle was maintained level.

In this regard, FIGS. **3–5** schematically illustrate a compartment having a substantially flat bottom wall whereas FIGS. **6–8** schematically illustrate a comparable compartment **39** of this invention having a V-shaped bottom wall **44**. FIGS. **3** and **4** respectively illustrate end and side elevational views of the flat-bottomed tray when it is maintained in a level condition of operation. The volume of lubricating oil shown therein is the approximate amount normally carried in each compartment and can be calculated by the equation

$V = WL\ (D+d)$, wherein:

V = Volume of oil in the compartment
W = Width of the compartment
L = Length of the compartment
D = Depth of oil below aperture **50'**
d = Height of oil above the aperture.

Typical dimensions of the above compartment are as follows:

W =8 inches
L =16 inches
D =2 inches
d =0.25 inch.

Application of such dimensions to the above equation results in a volume of oil in the compartment of 288 cu.in.

FIG. **5** is a side elevational view similar to FIG. **4**, but illustrating tray **49'** in a tilted position. In such position and with some of the oil having spilled-out through aperture **50'**, the remaining fluid can be calculated by the equation

$V = (HL/2)\ W$, Wherein:

H = Height of oil on the low side of the compartment which in this case is equal to **2D**.

Using the same dimensions as set forth above, the remaining volume is calculated to be 256 cu.in. Thus, 32 cu.in. of oil will have spilled-out of the compartment and into an annular chamber corresponding to chamber **38** whereby it will be free to run to the low side of the chamber, along with the oil contained on the high side thereof between the inner tray and the bottom wall (not shown).

FIGS. **6–8** are comparison views, similar to FIGS. **3–5**. The normal fluid level in a particular compartment **49** can be calculated by the equation

$$V = WL\ ([D/2] + d).$$

Using the same dimensions as set forth above, the volume of oil in compartment **49** is calculated to be 160 cu.in.

Tilting compartment **49** to its FIG. **8** position results in a spilling-off of some oil through aperture **50**. The volume of oil remaining in the compartment can be calculated by the equation

$V = WL\ ([D/2] + [D/12)$. The remaining volume is calculated to be 149.3 cu.in. which means that only 10.7 cu.in. of oil has spilled-out of compartment **49**, as compared to a spilling-off of 32 cu.in. from compartment **49'**.

Also, a comparison of the total volumes of oil carried by the respective compartments reveals that compartment **49** requires considerably less oil than compartment **49'**. Although this comparison is made for a single compartment of the respective trays, it is apparent that the total volume of oil maintained in the enclosure of this invention is considerably less than the total volume of oil maintained in the enclosure for the FIGS. **3–5** lubrication system.

The compartments **49** maintained on the low side of the tilted enclosure will also readily receive oil running downwardly therein from the high side. Since the upper structure of the excavator normally rotates between 90° to 180° during each digging cycle, some of the compartments on the low side will rotate to the high side and vice versa. However, compartments **49** will lose less oil than compartments **49'** when they are each rotated in a similar manner.

What is claimed is:

1. A horizontally disposed, annular enclosure enclosing a gear drive mechanism in an annular chamber thereof and lubricating means for communicating lubricating fluid to said gear drive mechanism and for maintaining a substantially uniform distribution of lubricating fluid circumferentially around said enclosure when said enclosure is tilted relative to its normal horizontal disposition, said lubricating means including an annular tray disposed in said annular chamber comprising contiguous sidewalls, a downwardly pointing bottom wall of generally V-shaped cross section and a plurality of circumferentially spaced plates disposed in said tray to extend radially inwardly between the sidewalls and said tray to divide the tray into a plurality of individual compartments.

2. The invention of claim **1** further comprising means forming a plurality of ports through a sidewall of said tray, adjacent to said gear drive mechanism, for communicating each of said compartments with said annular chamber.

3. The invention of claim **1** wherein said gear drive mechanism comprises a horizontally disposed, annular ring gear having teeth formed thereon which face radially inwardly towards a vertically disposed central axis thereof, and a pinion gear mounted for rotation about a vertically disposed axis thereof, parallel to said central axis, and meshing with the teeth of said ring gear.

4. A horizontally disposed, annular enclosure enclosing a gear drive mechanism in an annular chamber

thereof and lubricating means for communicating lubricating fluid to said gear drive mechanism and for maintaining a substantially uniform distribution of lubricating fluid circumferentially around said enclosure when said enclosure is tilted relative to its normal horizontal disposition, said lubricating means including an annular tray disposed in said annular chamber comprising contiguous sidewalls and a downwardly pointing bottom wall of general V-shaped cross section and said gear drive mechanism comprising a horizontally disposed, annular ring gear having teeth formed thereon which face radially inwardly towards a vertically disposed central axis thereof, and a pinion gear mounted for rotation about a vertically disposed axis thereof, parallel to said central axis, and meshing with the teeth of said ring gear.

5. The invention of claim **4** wherein an apex of the bottom wall of said tray is disposed substantially below said ring gear and further comprising lubricating oil retained in said chamber and in said compartments to at least cover lower portions of said ring gear.

6. The invention of claim **4** wherein said tray is interrupted circumferentially to define an opening, said pinion gear disposed in said opening.

7. The invention of claim **4** wherein said enclosure comprises wall means including vertically spaced and horizontally disposed annular upper and lower walls extending radially inwardly towards said central axis from said ring gear and a generally vertical and annular inner sidewall spaced radially inwardly from said ring gear and disposed generally vertically between said upper and lower walls, said lower wall having a generally V-shaped cross section generally conforming to the shape of the bottom wall of said tray.

8. The invention of claim **7** wherein said upper wall is secured to said support and wherein said lower wall is secured to said ring gear, and further including annular sealing means for effecting a fluid tight seal between said inner sidewall and said upper wall.

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