Nov. 25, 1958 G. LINKE ET AL 2,861,691

CENTRIFUGE FOR SEPARATING SOLIDS FROM SLIMY MASSES

Filed Jan. 20, 1955 4 Sheets-Sheet 1

Fig. 1

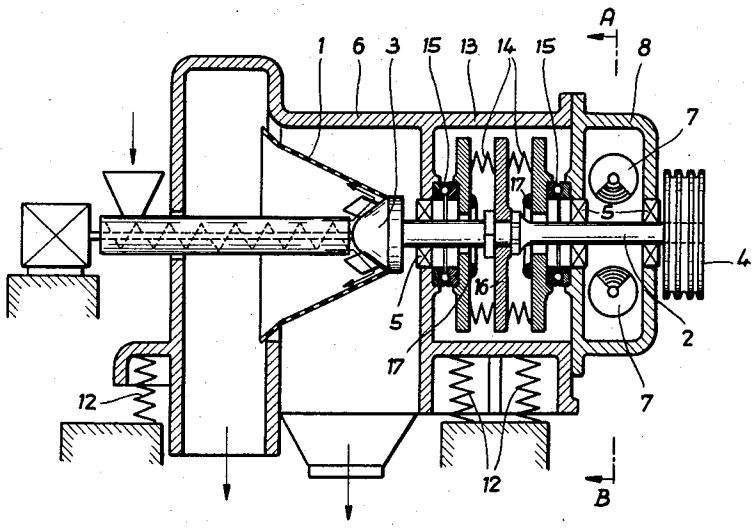

Fig. 2

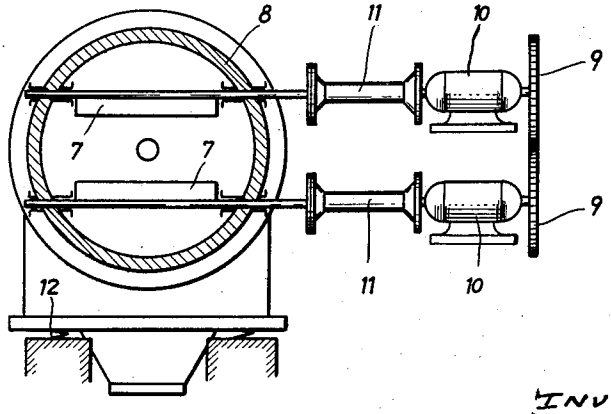

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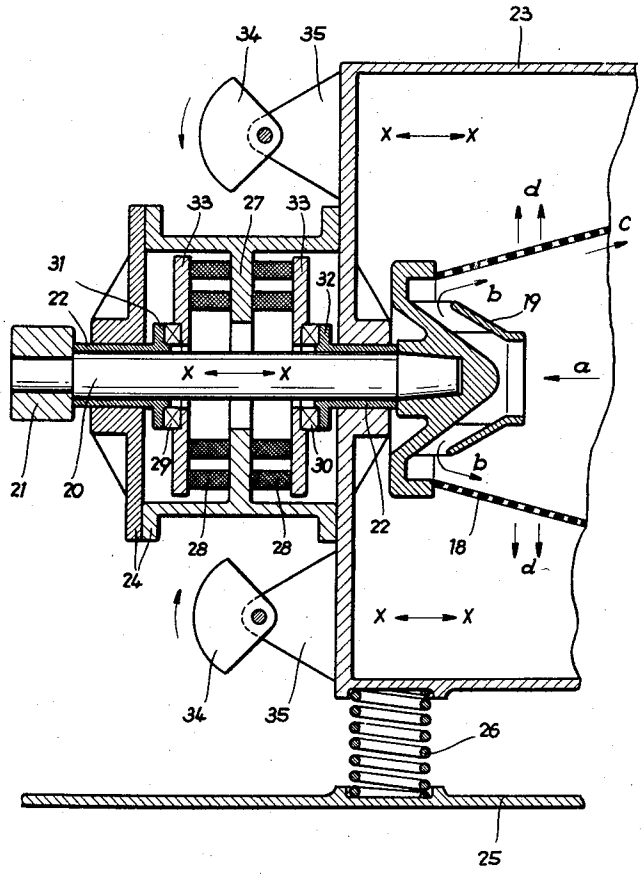
Fig.3



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CENTRIFUGE FOR SEPARATING SOLIDS FROM SLIMY MASSES

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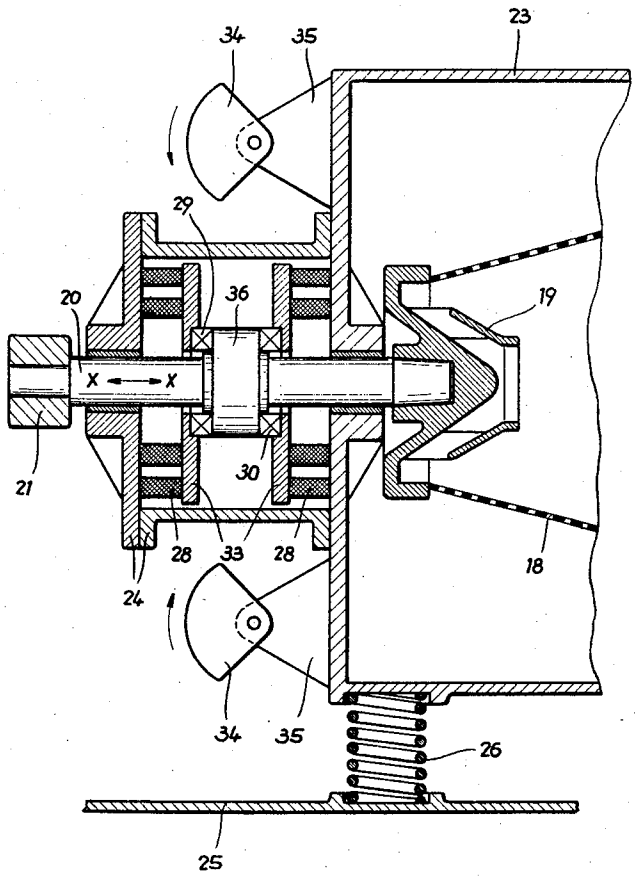
Fig. 4



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CENTRIFUGE FOR SEPARATING SOLIDS FROM SLIMY MASSES

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Fig. 5

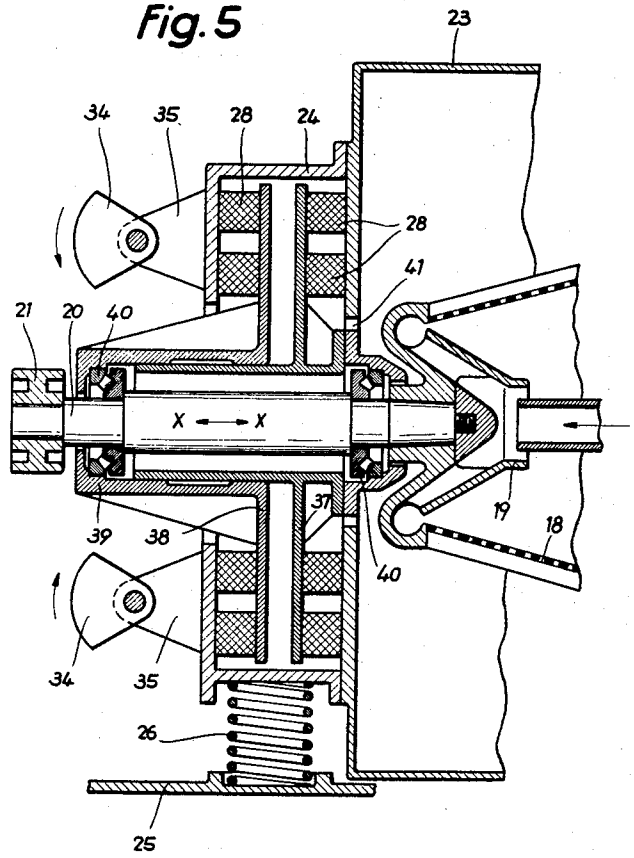
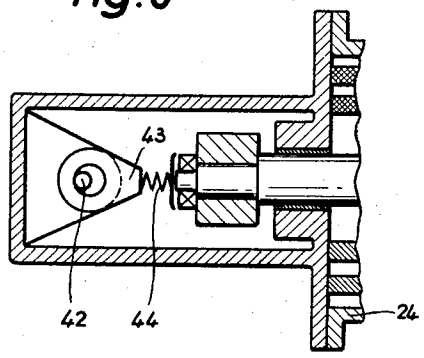


Fig. 6



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CENTRIFUGE FOR SEPARATING SOLIDS FROM SLIMY MASSES

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12 Claims. (Cl. 210—370)

This invention relates to centrifuges for separating viscous or slimy masses from their liquid carrier. Such masses may comprise pasty paint, rubber or plastic dispersions, emulsions, fertilizer or like industrial salt compositions, sludges containing coal particles, mine waste, or solutions containing sugar, solvents and the like.

In separating processes of the kind indicated it is essential for many purposes that during the centrifuging action the centrifuge drum or rotor should be caused to oscillate in the direction of the rotor axis. In order to induce such oscillations, it is necessary to provide flexible or elastic connecting members between the relatively rotatable parts and also to provide vibration-exciting means which are capable of co-operating with machine parts that rotate at a high rate of speed.

According to the invention a centrifuge for treating dispersions, emulsions, sludges and similar masses containing solid particles to be separated from said masses is provided with a drive shaft, which drive shaft carries on one of its ends conically shaped screening means and guiding means which latter extend a short distance into said screening means, and which drive shaft co-operates by way of anti-friction type thrust bearings with abutting means for elastic buffer members, and is further provided with a housing which, while acting as the other abutment for the said buffer members, is spring-supported from a frame or base, and finally with motor-driven vibrator means adapted to cause the said drive shaft and the means associated therewith to oscillate in an axial direction.

Also according to the invention, the said drive shaft and the screening means fixedly associated therewith, which screening means preferably comprise a centrifuging drum, are elastically coupled with the vibrating, spring-supported housing in such a manner as to cause said drive shaft and associated means to vibrate, preferably in a resonant manner, the arrangement being such that the spring elements may be stationary, while the said thrust bearings are pre-loaded by said spring elements. Thus, according to the invention, the rotary parts of the centrifuge are structurally independent of the vibration-producing means, it being possible, therefore, to design said vibration-producing means as non-rotating dependable elements of simple construction.

The said guiding means, which are mounted on said drive shaft, serve to guide and impel both the material being introduced into the centrifuge and the cake forming on the wall of said drum. According to the invention, said guide means may comprise a guiding cone member which extends only for a short length into the centrifuge drum. In view of the fact that with this type of construction the said guide means do not act as reinforcements for the centrifuge drum, the above-mentioned pre-loading of the thrust bearings by the elastic buffer members becomes of particular importance as regards the elimination of chattering motion, this applying especially for horizontal centrifuges as well as upwardly discharging centrifuges having more unfavorable natural frequencies of vibration.

It is another object of the invention to provide axial thrust bearings having a pre-load 20 percent greater than the maximum force introduced by the vibratory movements.

A further feature of the invention resides in the provision of abutting means in the form of spring retainers of which one retainer is directly connected with the housing of the thrust bearing, whereas the other spring retainer is mounted on or integral with a sleeve which is in turn mounted for sliding movement and which is adapted to surround said bearing housing.

These and other objects and advantages of the invention will become further apparent from the following detailed description, reference being had to the accompanying drawings showing certain preferred embodiments of the invention.

In the drawings:

Figure 1 is a fragmentary sectional view of a centrifuge embodying features of the invention.

Figure 2 is a transverse section taken along the line A—B in Figure 1.

Figure 3 is a fragmentary sectional view of a modified form of the invention.

Figure 4 is a fragmentary sectional view of a further modified form of the invention.

Figure 5 is a view similar to that of Figure 4.

Figure 6 is a fragmentary sectional view of a modified construction of the proposed vibration-producing means used in the embodiment of Figure 4.

Referring now more particularly to the drawings, there is disclosed in Figures 1 and 2 a centrifuge system comprising a horizontal shaft **2** having mounted on one end thereof a perforated or screen drum **1** into which the hereinabove mentioned mass is fed from a hopper **1***a* via a power driven screw conveyor **2***a*. The conical impeller and guide arrangement **3** toward which said mass is moved forms the hub of said drum **1**. The shaft **2** is driven by means of pulley **4**. The shaft **2** is carried in cylindrical roller bearings **5** mounted in the housing **6** in such a manner that, while rotating, it can also oscillate in an axial direction.

These axial oscillations of said shaft **2** are produced by the rotating eccentric weights **7** which are mounted for rotation in the frame member **8** of the housing structure. The two eccentric weights **7** are driven for rotation by two known drive means **10** which are synchronized by two gear wheels **9** and which deliver their power to said weights through elastic universal-joint shafts **11**. While the centrifugal forces set up by the eccentric weights **7** are additive in a horizontal direction, i. e. in the direction of the axis of shaft **2**, they cancel each other out in a vertical direction. It will be appreciated that the entire machine, which is elastically supported by helical springs **12**, is caused by the eccentric weights **7** to oscillate in a horizontal direction, these oscillations having a relatively small amplitude.

Arranged in the compartment **13** of the housing is a double-acting spring arrangement **14** comprising rubber buffers or helical springs which are mounted between thrust bearings **15**, the spring arrangement **14** being capable of rotating together with the rotor of the centrifuge. The pre-load acting on the thrust bearings must be considerably greater, preferably by twenty percent, than the alternating forces set up by the two masses which vibrate in mutual opposition. The preloading of the springs **14** will have to be of a corresponding magnitude; otherwise chatter would occur in the thrust bearings **15** and this would soon cause bearing failure.

Under the influence of the small-amplitude horizontal vibrations of the housing caused by the eccentric weights **7** the rotor **1** of the centrifuge, together with shaft **2** and the central spring abutment **16** between the sets of springs

14, which constitute the smaller vibrating mass of the system, will oscillate in an axial direction with an amplitude which is inversely proportional to the weight or mass of the machine frame. The greater the correspondence between the frequency of the vibration-producing means 7 and the natural frequency of the oscillating system the greater the amplitude.

The characteristics of the oscillating system are given by the masses of the rotor 1, the shaft 2, the spring abutment 16, the spring constant of the spring arrangement 14 and the masses of the machine housing 6.

At its points of extreme deflection the spring abutment 16 can in turn abut against the rubber buffers 17, this arrangement giving a non-harmonic spring characteristic, reducing the tuning sensitivity of the system and improving the efficiency with which the filter cake is discharged by the axial vibrations of the centrifuge drum.

In the embodiment of Figure 3, the reference numeral 18 indicates the conical centrifuge drum which is usually perforated but which may, if desired, have a continuous shell; this drum has a hollow hub 19 carrying guide means in the form of fins or blades toward which the material to be processed is led in the direction of the arrow "*a*" and from which the material passes along the arrow "*b*" to the inside of the drum. The drum 18 carries the centrifuged and thus dried material away in the direction of the arrow "*c*," whereas the fluid or liquid separated from the material will be discharged in the direction of the arrows "*d*" through the perforations of the drum or the screen-like lining thereof.

The centrifuge drum 18 is rigidly secured to the shaft 20 which is driven for rotation by means of a clutch or coupling, a gearing or a pulley 21. The shaft 20 is carried in the bearings 22 mounted in the housing 23 and in the housing section 24 of the vibration-producing means, respectively. The housing 23 and with it the centrifuge is elastically supported by rubber buffers or springs 26 on a base or foundation 25.

Provided in the housing section 24 is a circular partition 27 forming an abutment having a central aperture, which partition rests on either side against sets of springs or rubber buffers 28 which latter are preloaded against the bearings 29 and 30, which bearings are thus pressed against collars 31 and 32 of said bearings 22 in which shaft 20 is supported.

It will be seen that there is thus created a two-mass system comprising the large mass of the centrifuge housing 23, 24 which vibrates only in an axial direction, and the small working mass 18, 19, 20 which rotates and simultaneously oscillates in an axial direction. Interposed between the said two masses are operable means in the form of preloaded spring or buffer arrangement 28, the bearings 29 and 30 and the spring abutments 33. In this manner the vibration-producing mechanism is left independent of any rotary motion, this being done by elastic means and in a manner tending to reduce the stresses imposed on the component parts of the machine. Vibrations may be excited in this oscillating system either by means of a single eccentric weight 34 or by means of two such weights arranged to act in opposition to one another, these weights being mounted on the centrifuge housing 23, 24 by suitable brackets 35.

During operation of the embodiment of Figure 3 the shaft 20 rotates the drum 18, this rotation producing the centrifugal acceleration necessary for a centrifuging action. At the same time the eccentric weights 34 mounted on the elastically supported housing 23 are rotated in opposite directions, causing vibrations in the longitudinal direction of the centrifuge, i. e. in the direction of the double-headed arrow X—X. This longitudinal oscillation is set up because in any other position of the eccentric weights 34, for example if said weights are rotated 90° from the position shown in Figure 3, the centrifugal forces produced by said weights will cancel one another. The housing section 24 will oscillate axially together with the housing 23, the partition 27 and the sets of springs or rubber buffers 28 serving to transmit the oscillations to the rotor. It is preferable that the masses in question and the spring constants should be selected in such a manner as to produce resonance.

For an advantageous operation of the arrangement just described it is essential that the sets of springs 28 are pressed against the collars 31 and 32 of the shaft 20 or its bearing sleeves by way of the abutments 33, and the bearings 29 and 30 which are preferably formed by anti-friction bearings. In this manner the anti-friction bearings remain under preload and no chatter can develop. It will thus be seen that in this case only the axial vibrations are superimposed to the rotation of the shaft 20.

In Figure 4, which illustrates a modified embodiment of the invention, those parts which correspond to similar parts in Figure 3 bear similar reference numbers. These two embodiments differ only in that different arrangements are used in the vibration-producing mechanisms. According to Figure 4 the housing 24 of the vibration-producing means has no partition, but the buffers are arranged so as to abut against the inner end walls of said housing, whereas on the inside, i. e. remote from said end walls, said buffers abut against ring members 33 which in turn press against the bearings 29 and 30 which again are held under preload against a collar 36 of the drive shaft 20. Otherwise this vibration-producing mechanism is identical with that described in connection with Figure 3.

The embodiment illustrated in Figure 5 is characterized by the fact that only a small number of bearings are used. Moreover, in order to reduce the bulk of the machine, the eccentric weights 34, together with their respective brackets 35, are mounted on the housing section 24. Otherwise the construction of this embodiment is identical with that of the embodiments of Figures 3 and 4.

As will be seen in Figure 5, the rubber buffers 28 or equivalent sets of springs are mounted between the end walls of the housing members 23 and 24 on the one hand and the radial flanges 37 and 38 on the other, which flanges are formed on members forming the bearing structure supporting the shaft 20. The flange 37 is integral with the bearing housing of the shaft 20, whereas the flange 38 is integral with a sleeve 39 which is slidably mounted and embraces the housing of bearing 40. The shaft 20 is carried in the bearing housing in two tapered roller bearings 40 which serve to transmit to the shaft 20 the vibrations occurring in the direction of the double-headed arrow X—X. The preload on the spring elements 28 acts through the sleeve 39 to maintain the above-mentioned parts in mutual contact.

Also the embodiment of Figure 5 gives a simple construction and ease of assembly, permits the tension of the spring elements to be adjusted to suit requirements of the practice, to eliminate rotation of the parts housed in the section 24 and also to reduce the number of bearings required. It is, of course, necessary to provide a gap 41 between the bearing arrangement for the shaft and the housing 23 to thereby permit longitudinal movement of the rotor assembly which tends to oscillate to a higher degree in the presence of resonance.

The embodiments shown in Figures 3 to 5 may be modified in accordance with Figure 6 by causing the two relatively oscillating masses to be moved by a spring drive mechanism comprising an eccentric shaft 42 supported by the housing 24, a push rod 43 and a drive spring 44.

The arrangements hereinbefore described may also be used to good advantage in machines of the vertical type as well as in machines having a non-perforated centrifuging drum. Where it is possible, in view of the masses involved, to increase the amplitude of the oscillations, the eccentric weights used to produce the vibrations may be replaced with electro-magnetic means or an elastically

coupled crank. The features of the invention here disclosed may also be used in the appropriate sense to produce superimposed torsional vibrations.

Various other changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus particularly described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A centrifuge system having a screen drum body and a rotatable drive shaft to which said body is connected; housing means biased against a support therefor and enclosing said drum and said shaft, eccentric means rotatably supported by said housing means and constructed to produce oscillations of said housing means in substantially axial direction of said drive shaft, journal means for said drive shaft to support the latter during rotation thereof, and operable means supported in said housing means and positioned to extend along substantially the entire shaft and intermediate said journal means, said operable means transferring said oscillations of said housing means to said shaft, whereby the latter in addition to its rotational movement performs also oscillations in axial direction thereof, resulting in an increased output of said drum.

2. A system according to claim 1, said operable means including central abutment means, elastic buffer means arranged at either side of said central abutment means, and outer abutment means for said buffer means, said buffer means being preloaded between both said abutment means.

3. A system according to claim 2, wherein said journals are operatively connected to said outer abutment means.

4. A system according to claim 2 including rubber buffers, said central abutting means being mounted on said shaft and abutting said buffer means which are arranged for position against the inner faces of said outer abutment means, thus producing a non-harmonic spring characteristic, and two thrust bearings, respectively engaged between said outer abutting means and adjacent portions of said housing means which carry said journal means and said shaft.

5. A system according to claim 2, in which said central abutment means forms a circular partition connected with said housing means, said partition being provided with a central opening for the passage of said shaft, said outer abutment means being mounted on said bearings, which are supported against collars provided on said journal means for said shaft.

6. A system according to claim 2, said housing means including inner end walls forming said outer abutment means.

7. A system according to claim 2, said housing means including inner end walls forming said outer abutment means, respectively, said central abutment means being constituted by two spaced apart flanges directed radially of said shaft, one of said flanges forming an integral part of a bearing sleeve for said shaft, whereas the other flange is integrally formed with a sleeve member slidably

mounted on said bearing sleeve, and roller bearing means for said shaft seated in said bearing sleeve.

8. A system according to claim 4, said operable means including a double-acting spring arrangement connected to said drum and said shaft and constituting a relatively smaller vibration mass than the mass formed by said enclosing means with said eccentric means, whereby said oscillations in axial direction of said shaft caused by said eccentric means are of an amplitude inversely proportional to the weight of said enclosing means.

9. A centrifuge system having a screen drum body and a rotatable drive shaft to one end of which said body is connected; means enclosing said drum and the major portion of said shaft and yieldably supported on a base, eccentric means operable on said enclosing means and constructed so as to produce during operation oscillations of said enclosing means only effective axially of said drive shaft, bearing means supporting said drive shaft, and operable means supported by said enclosing means and operatively connected to and extending between said bearing means to thereby transfer said oscillations produced by said eccentric means via said enclosing means to said shaft, whereby the latter in addition to its rotational movement performs also oscillations in axial direction thereof, resulting in improved efficiency of said drum.

10. A system according to claim 9, said eccentric means comprising two oppositely rotatable eccentric weights each connected to a universal-joint shaft, and drive means rotating said universal-joint shafts in unison.

11. A centrifuge system having a screen drum body and a rotatable drive shaft connected adjacent one of its ends with said body; comprising means yieldably supported on a base and enclosing said drum and at least a part of said shaft, oscillation-producing means connected to said enclosing means and constructed to produce oscillations of said enclosing means effective axially of said drive shaft, bearing means supporting said drive shaft, and operable means carried by said enclosing means and operatively connected to said bearing means and located to extend therebetween to thereby transfer said oscillations to said shaft, whereby the latter in addition to its rotational movement performs also oscillations in axial direction thereof, to thereby enhance the efficiency of said drum.

12. A system according to claim 1, in which said eccentric means comprise an eccentric shaft supported by said housing means, a push rod, and spring means between the push rod and said shaft and acting in axial direction of said shaft.

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