Aug. 8, 1961 J. BAXTER, JR 2,995,310

PAPER MACHINERY

Filed Dec. 2, 1958 2 Sheets-Sheet 1

FIG-1

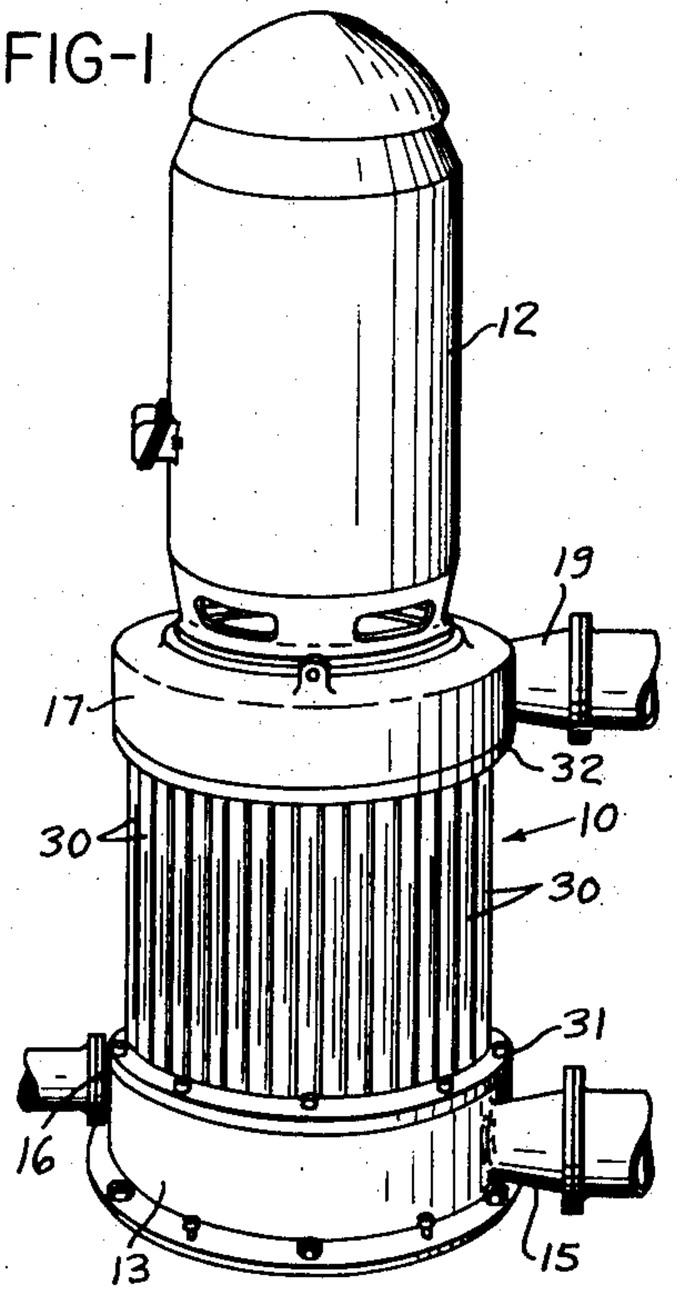

FIG-2

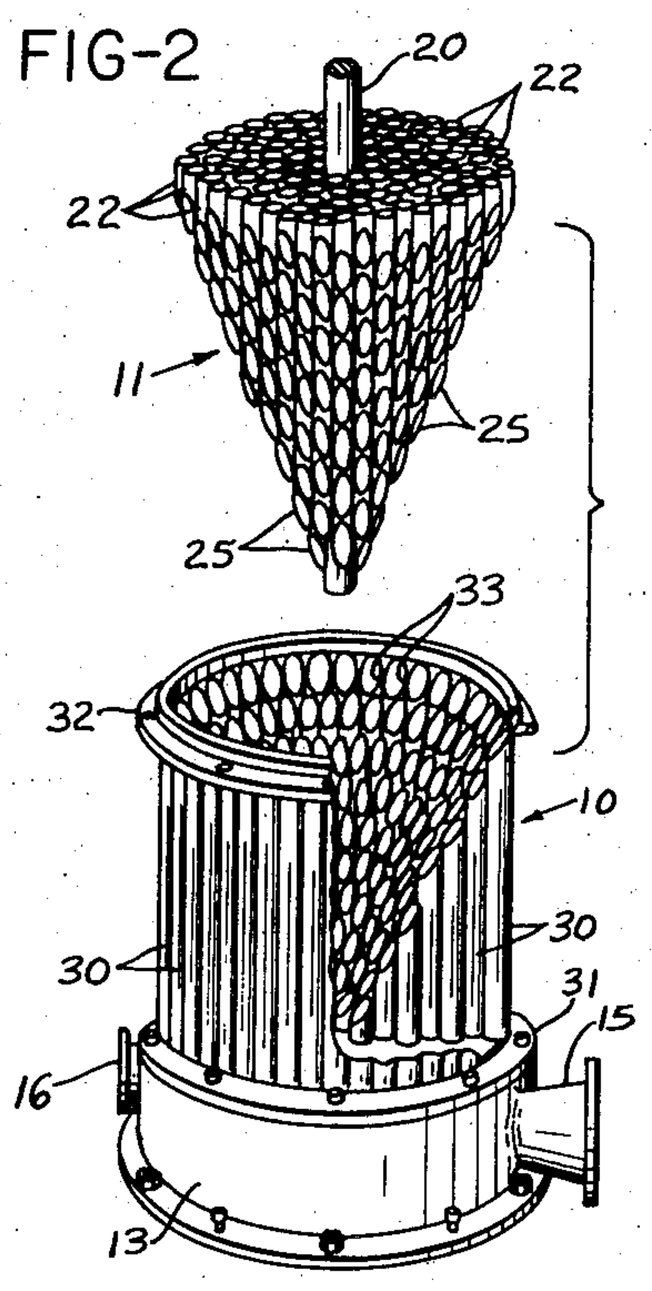

FIG-3

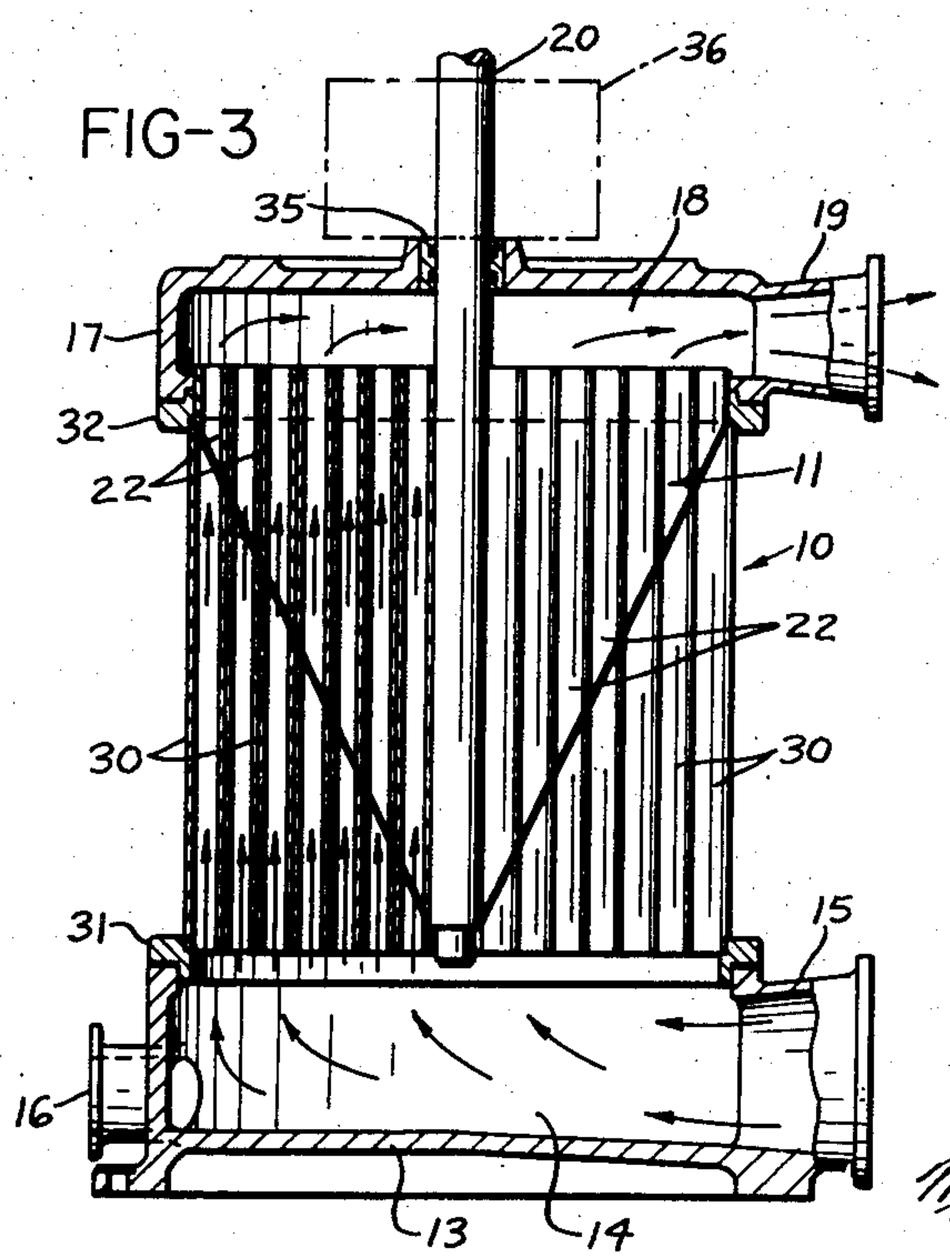

FIG-4

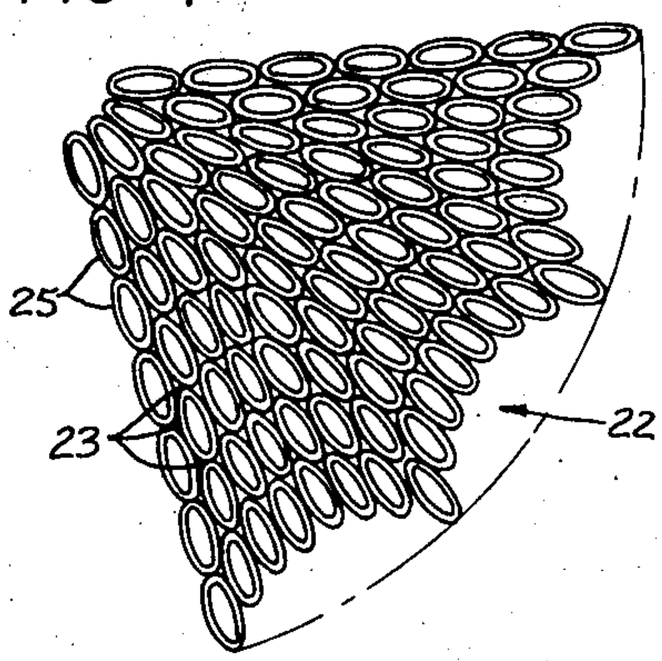

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FIG-6

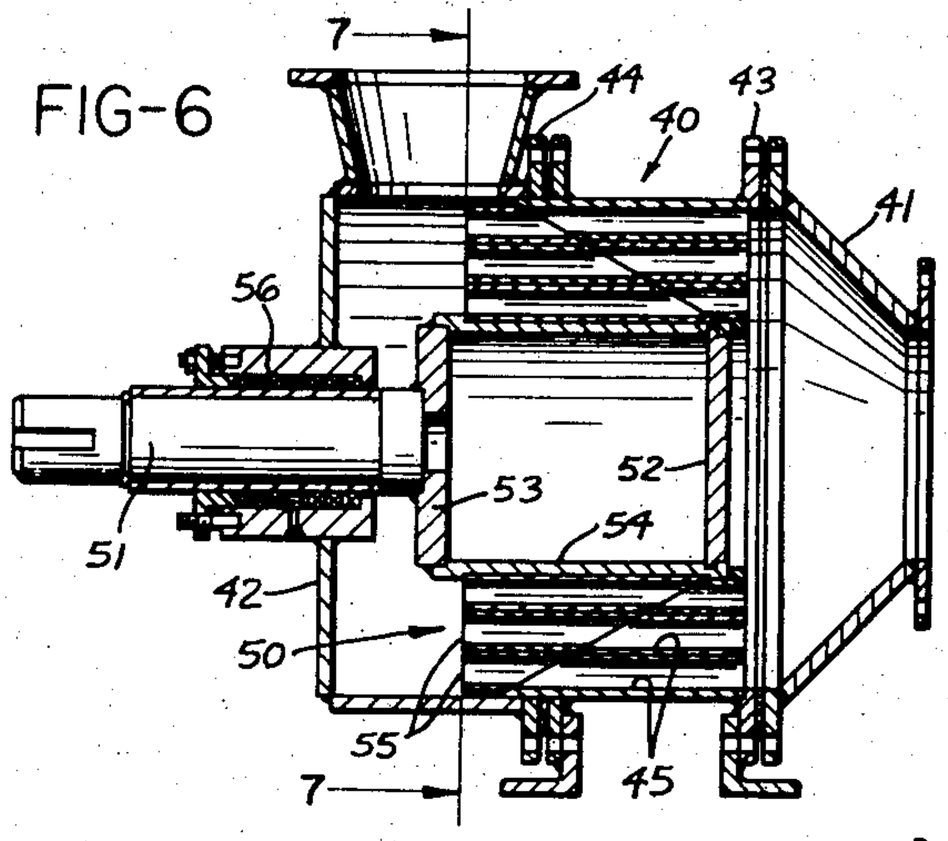


FIG-8

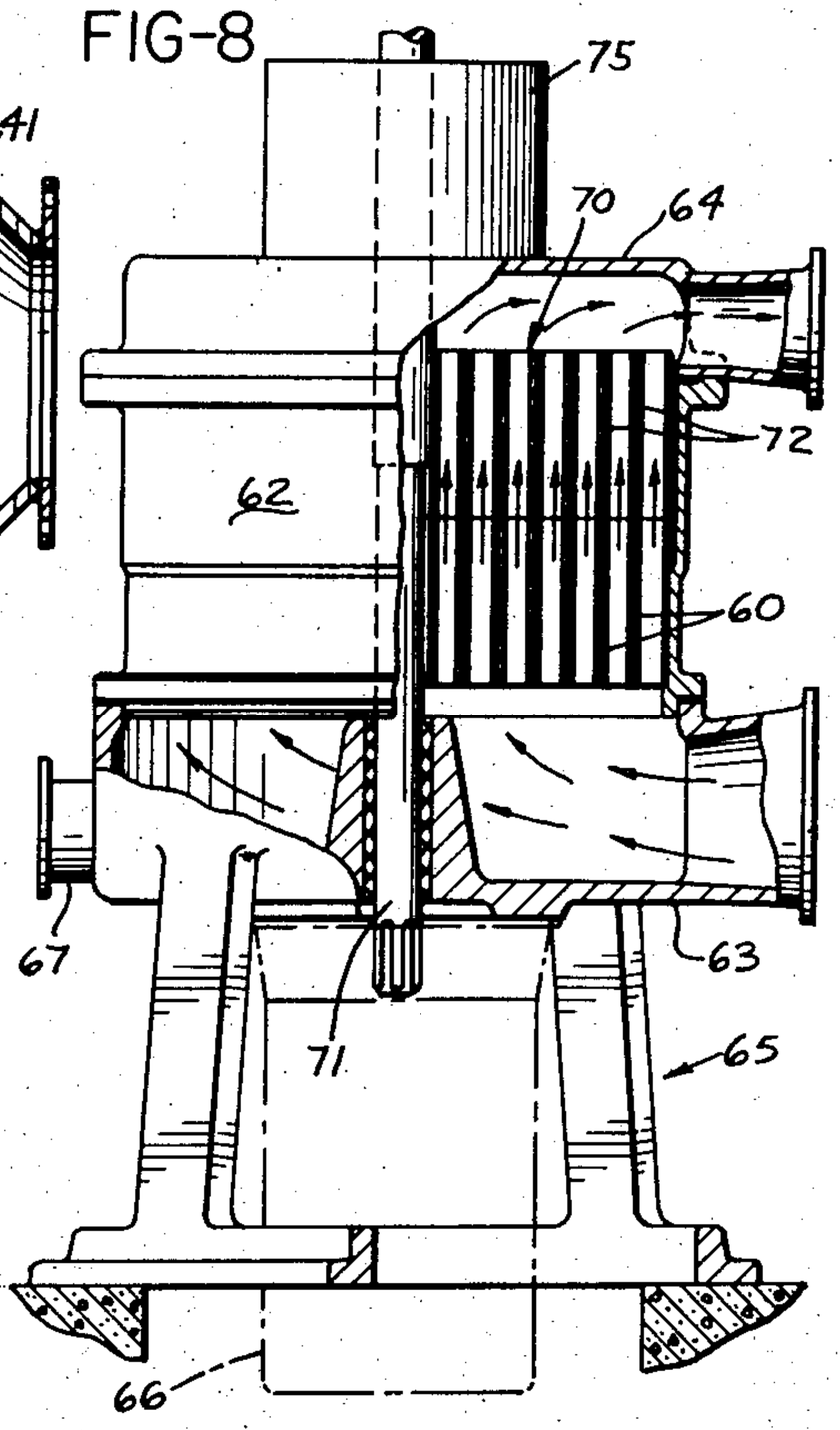


FIG-7

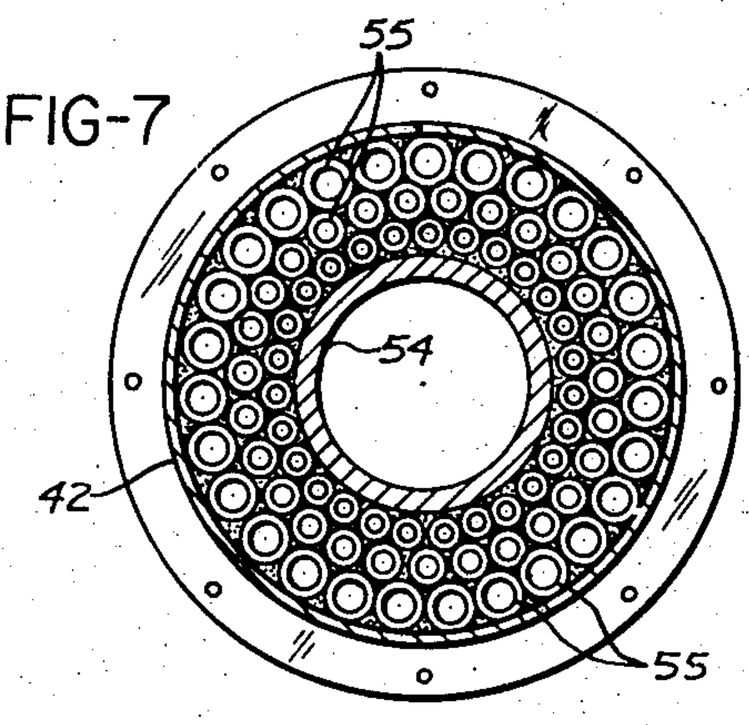


FIG-5

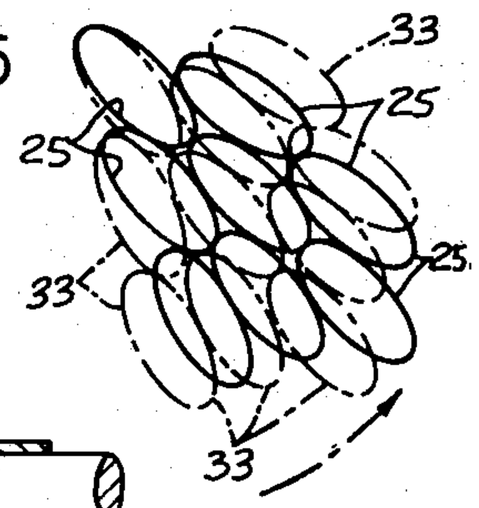
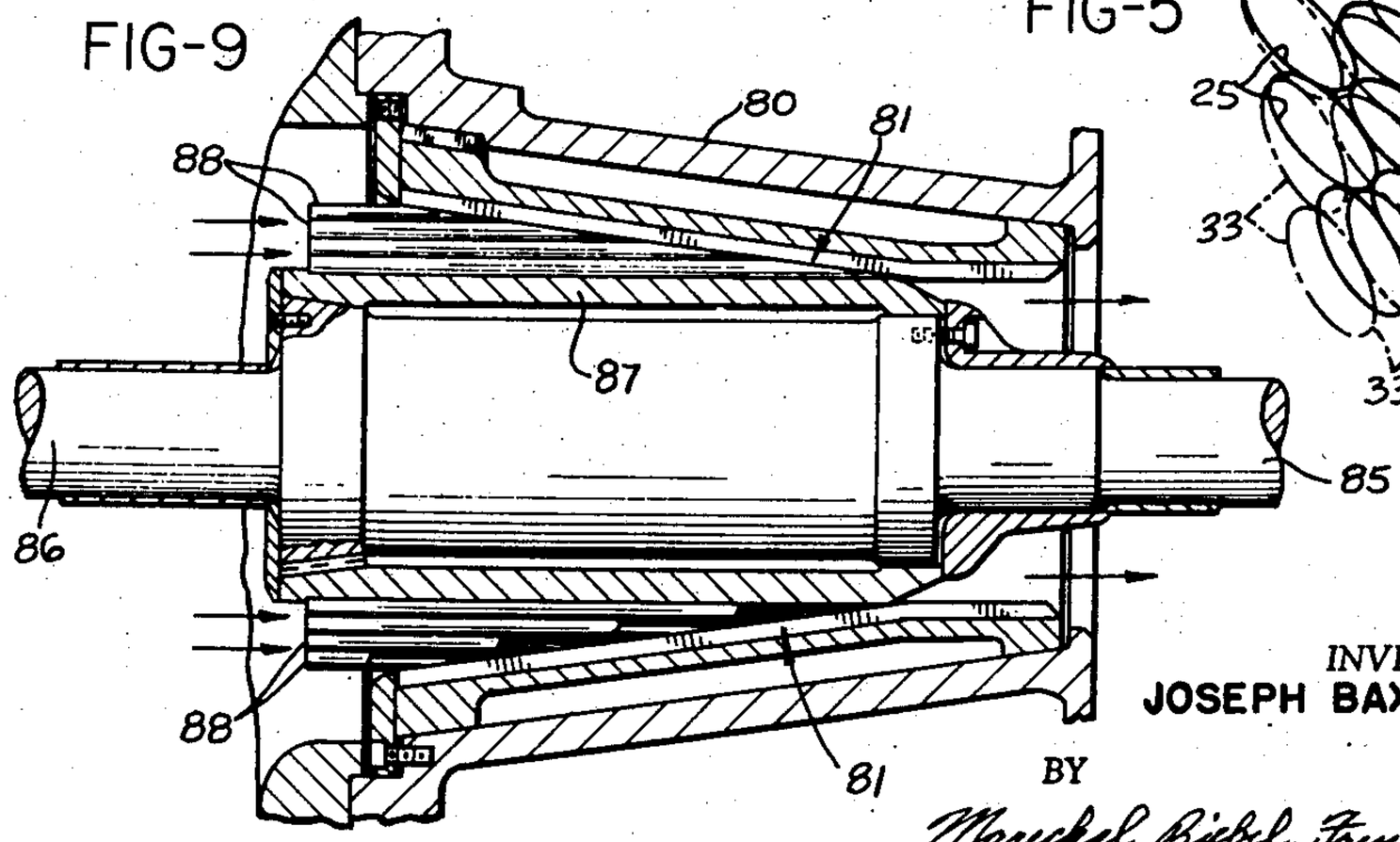


FIG-9



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10 Claims. (Cl. 241—46)

This invention relates to rotary refiners for liquid slurry stocks such as paper making stock, and more specifically to such refiners of the type incorporating a rotary plug and a stationary shell which have cooperating working surfaces on their adjacent faces for effecting working of the stock therebetween.

One object of the invention is to provide a rotary refiner generally of the above outlined type which is of improved and novel construction such that the effective extent of the total working surfaces of the plug and shell is substantially greater than in similar refiners of conventional construction and comparable dimensions, and which therefore offers substantial advantages of increased efficiency as well as economical production and operation.

It is also an object of the invention to provide a rotary refiner which is of such structure and mode of operation that the effective capacity of its working members is not reduced by wear in use and which therefore maintains sustained maximum capacity throughout its working life.

An additional object is to provide a rotary refiner which is of such structure and mode of operation as to offer a substantially uniform flow area through both the working zone thereof and also through the entry to the working zone, and thereby to afford increased capacity and improved control over the working of the stock therein.

Another object of the invention is to provide a rotary refiner having the characteristics outlined in the preceding paragraph wherein the plug is of novel construction comprising a multiplicity of enclosed through passages arranged in closely spaced relation such that the material of the plug defining the inner ends of these passages forms a honeycomb-like network of working edges opposed to the cooperating working face of the shell.

A further object of the invention is to provide a rotary refiner generally as outlnied above wherein both the plug and shell have multiple enclosed passages extending therethrough in such manner and direction that the material defining the adjacent ends of these passages forms opposed networks of working edges for cooperating action on the stock flowing through the shell as the plug rotates therein.

A still further object of the invention is to provide a rotary refiner wherein the body of the plug or of both the plug and shell is in substantial measure composed of multiple tubes bonded together in axially arranged parallel relation to provide multiple enclosed through passages with the inner ends of these tubes forming the desired network of working edges for working on the stock as it flows therebetween through the shell.

It is also an object of the invention to provide a rotary refiner as outlined above wherein the plug and shell are adapted for construction in a variety of desired configurations including generally cylindrical as well as a range of frustoconical configurations in accordance with the effective area of the working surfaces thereon to be obtained in a refiner of desired overall size.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawing and the appended claims.

In the drawing—

FIG. 1 is a perspective view of a rotary refiner constructed in accordance with the invention and generally of the jordan type incorporating a frustoconical plug;

FIG. 2 is a partial exploded view, partly broken away, of the plug and shell in the refiner of FIG. 1;

FIG. 3 is a fragmentary view of the refiner of FIG. 1 taken partly in side elevation and partly in vertical section;

FIG. 4 is a fragmentary developed view of the working surface of the plug in the refiner of FIGS. 1–3;

FIG. 5 is a diagrammatic view illustrating the working action of the refiner of FIGS. 1–3;

FIG. 6 is a view in axial section showing another conical refiner constructed in accordance with the invention;

FIG. 7 is a section on the line 7—7 of FIG. 6;

FIG. 8 is a view partly in side elevation and partly in section through another form of refiner in accordance with the invention constructed to locate the working faces of the plug and shell in radial planes; and

FIG. 9 is a fragmentary view in axial section showing a conical refiner embodying a conventional shell filling and plug constructed in accordance with the invention.

Referring to the drawings, which illustrate preferred embodiments of the invention, the refiner shown in FIGS. 1–4 comprises three main elements—a shell indicated generally at **10**, a frustoconical plug **11**, and a drive motor **12** mounted on the upper end of the shell for driving the plug. The base casting **13** of the shell encloses an inlet chamber **14** and incorporates the inlet port **15** for stock and also a discharge port **16** for heavy junk which may be connected to a suitable junk trap (not shown). The top casting **17** of the shell forms an outlet chamber **18** incorporating a tangentially arranged outlet port **19** for the refined stock, and it also serves as a base for supporting the drive motor **12**.

The plug **11** is best seen in FIG. 2, and it is composed of a central supporting shaft **20** and a plurality of tubes **22** nested in parallel relation around the shaft **20** and welded or otherwise secured thereto and to each other, for example by means of brazing metal substantially filling the interstices therebetween as indicated at **23** in FIG. 4. These tubes **22** thus form the body of the plug, and at the same time they provide a corresponding plurality of enclosed passages extending axially through the plug. In addition, the inner end of the plug is ground to a frustoconical configuration which in turn imparts an elongated shape to the annular inner end **25** of each of the tubes **22** as is also best seen in the developed view in FIG. 4. These end edges **25** of the several tubes **22** constitute the working edges of the plug, and FIG. 4 shows the honeycomb-like network which these working edges form.

The working section of the shell **10** is also composed of a multiplicity of axially arranged tubes **30** secured together in similar manner to the plug tubes **22** and mounted between end rings **31** and **32** which are in turn directly attached to the end castings **13** and **17** as shown, and the tubes **30** thus themselves form the body of the working section of the shell and do not require an outer casing. The inner end face of the assembled tubes **30** is ground to a frustoconical configuration complementary to that of the plug **22**, thus imparting to the annular inner ends **33** of the individual tubes **30** an elongated shape as shown in FIG. 2 which also in a developed view has the appearance represented in FIG. 4, and these working edges **33** thus cooperate to form a honeycomb-like network complementary to that on plug **11**.

In the operation of this unit as illustrated in FIG. 3, the plug **11** is suspended by the shaft **20** from the upper casting **17** in suitable bearings **35** and is driven by the motor **12** to rotate in the shell. The stock pumped into the port **15** is subdivided by the shell tubes **30** into a corresponding multiplicity of individual streams which are discharged from the inner ends of the tubes **30** and are

therefore forced to enter one or more of the similar passageways provided by the tubes **22** in the rotating plug. It will also be noted that while the grooves on the outer surface of the plug may be filled out with additional metal to a cylindrical shape, this is not necessary, and in fact these grooves cooperate with the shell end ring **32** to form additional passages leading into the inlet chamber **18** from the passages formed by the shell tubes **30**.

As each of the streams from the shell tubes **30** crosses the space between the opposed working edges **25** and **33** of the plug and shell, it is subjected to extensive working between these relatively moving working surfaces, and a number of factors contribute to this result. Thus it will be apparent from FIG. 4 that the total linear extent of the working edges **25** and **33** is very substantial, and especially that it is substantially greater than the linear extent of the bar edges on the plug and shell of a conventional jordan refiner of comparable size. It follows, therefore, that the frequency with which these edges cross each other as the plug rotates is correspondingly much higher than in the conventional jordan, and also this action results in breaking up the stream discharged from each of the shell tubes into a plurality of separate stream portions which merge with portions of the discharge from other shell tubes as they enter one or another of the plug tubes.

Some of the working characteristics of the unit of FIGS. 1–4 are further illustrated by FIG. 5, which is diagrammatic representation of the action of the end faces **25** of a group of the plug tubes **20** in passing the end faces **33** of a corresponding group of shell tubes **30**, the faces **25** and **33** being represented respectively in full and dotted lines. As each tube face **25** moves in the direction of the arrow, its leading edge progressively pinches off the discharge from a tube **30**, thus both forcing the stock therefrom to flow laterally and at the same time working some of the fiber against the end face **33**. This action progresses until the tubes reach their position of maximum coincidence, after which the trailing portion of the face **25** again pinches off the tube **30**, and this action is repeated at relatively high frequency with the entire end face of each tube thus taking part in the brushing action on the fiber passing therebetween.

It will also now be seen that the operation of this unit gives rise to substantial hydraulic working of the fiber as well as the mechanical working already described. Thus the forced subdividing and remixing of the stream from each shell tube introduces velocity changes setting up substantial forces of hydraulic shear which are highly desirable in the refining action. In addition, desirable features are obtained if the material filling the spaces between the several tubes in both the plug and shell is sufficiently softer than the tubes themselves to erode at a slightly faster rate than the tubes wear away and thereby to provide networks of passages in the working surfaces of the plug and shell which further contribute to the hydraulic action while also assuring a maximum of exposed working edges on both sets of tubes.

It will be apparent that the plug **11** does not provide a pumping action equivalent to that of a conventional jordan plug of comparable size, due to the passages running axially therethrough, but there is still some inherent pumping tendency resulting from the action of centrifugal force. This action, coupled with the repeated crossings of the respective working edges of the plug and shell, gives rise to a definite tendency for the solid material in the stock to travel radially outwardly along the entire face of the plug and shell before it enters one of the plug tubes, which further increases the amount of mechanical working to which it is subjected. In addition, the structure of this refiner makes it inherently impossible for any stock to traverse the unit without being subjected to some mechanical working, which is not the case in conventional jordans in that it is always possible for some stock to channel directly between the bars in the plug and shell from one end of the unit to the other without ever coming between opposed working edges of the two sets of bars.

This refiner construction as shown in FIGS. 1–4 therefore offers substantial advantages over conventional refiner construction from the standpoint of its mechanical action on the stock, and also it offers substantial advantages in the simplicity of its structure and the economy of its manufacture and use. For example, the use of individual tubes assembled as described to form the major components of both the plug and shell offers a particularly advantageous approach to providing the desired multiple enclosed passages in the plug and shell. Thus such tubes are commercially available in a wide variety of sizes and metals suitable for the purposes of the invention, such as stainless steel, bronze and cast iron, and satisfactory results have been obtained with tubes of a wall thickness of ⅛ to ½ inch and of an outer diameter in the range of 1.25 to 1.75 inches. The individual tubes are therefore relatively inexpensive, and also the manner of assembling and securing them together in accordance with the invention is simple and economical, since they can be welded together to build up the plug and shell to the desired proportions. As already noted, this manner of construction offers the further advantage of making it possible to eliminate a separate housing or casing for the shell.

A further and major advantage of the invention is the ease of adjustment to compensate for wear, coupled with the fact that the effective capacity of the unit is not reduced by wear. Thus in a conventional jordan refiner, as the bars which form the filling of the plug or of both the plug and shell wear down, the channels between adjacent bars decrease in depth and thus reduce the flow area through the unit as the plug is adjusted inwardly of the shell to compensate for bar wear. It is for this reason that the wood spacers or fillers between the bars are chipped away from time to time in conventional jordan practice.

With the present invention, and in contrast to conventional jordan practice as just noted, wear of the tubes **22** and **30** simply reduces their axial dimensions but not the effective flow area therethrough. The capacity of the unit will therefore remain substantially uniform irrespective of wear, and the wear is readily compensated for by adjusting the plug axially inwardly of the shell. In this connection, it should be understood that conventional axially adjustable mountings for the plug **11** may be used such, for example as the automatically adjustable mounting disclosed in Stategе et al. Reissue Patent No. Re. 24,185, and such an adjustable mounting is indicated diagrammatically at **36** in FIG. 3.

A further advantage of the invention derives from its adaptability to refiners of different individual proportions. Thus FIGS. 6 and 7 show a refiner which is generally similar to the refiner shown in FIGS. 1–3 but in which the angle of taper of the working face of the plug is substantially flatter than in FIGS. 1–3 to provide for a more compact unit. The shell **40** in FIGS. 6 and 7 is constructed similarly to the shell **10** and includes an inlet casting **41**, an outlet casting **42**, and end rings **43** and **44** which cooperate with the multiple tubes **45** to form the working section of the shell.

The plug **50** in FIGS. 6 and 7 is also generally similar to the plug **11**, but in order to provide a more compact unit of adequate capacity and working speed, the plug is made up of a shaft **51**, a pair of end disks **52** and **53** and a cylindrical core **54** on which the individual tubes **55** are welded in the same general arrangement as shown in FIG. 2. FIG. 7 also shows how in a unit of these proportions, it may be advantageous to use tubes **55** of different diameters in the same unit, and FIG. 6 shows a similar arrangement of tubes **45** in the shell. The mounting **56** for the plug shaft **51** is shown as incorporating a conventional stuffing box, and it will be understood that the unit may incorporate conventional mechanism for effecting

adjustment of the plug within the shell as already described.

FIG. 8 shows a refiner in accordance with the invention wherein the plug and shell are essentially cylindrical to locate their respective working faces in radial planes and thereby to provide a working action more closely comparable to that of a disk refiner than a conical refiner. More specifically, the multiple tubes **60** in the shell are all of the same length and are secured within an annular casting **62** which is in turn secured at its opposite ends to the inlet casting **63** and outlet casting **64**. The inlet casting **63** is shown as incorporating a pedestal **65** proportioned to receive the drive motor **66** for the plug, and FIG. 8 also shows the inlet casting as connected with a suitable junk trap **67** such as may be connected to the outlet **16** in FIGS. 1–3.

The plug **70** in FIG. 8 is constructed generally in the same manner as shown in FIG. 2 to incorporate a drive shaft **71** and multiple tubes **72** which are similar to the shell tubes **60** in that they are also all of the same axial length to locate their working faces in a common radial plane. Otherwise, the unit of FIG. 8 is comparable in structure and operating characteristics to the units already described in connection with FIGS. 1–7. It will also be noted that the location of the drive motor **66** facilitates the mounting of adjusting mechanism **75** for the plug shaft **71** on top of the outlet casting **64**, and the same arrangement is equally applicable to the refiners of the invention incorporating conical plugs.

FIG. 9 shows how a plug constructed in accordance with the present invention may be adapted for use in the shell of a conventional jordan refiner. Thus FIG. 9 shows a fragment of the shell **80** of a conventional jordan incorporating a standard type of bar filling indicated generally at **81**. The plug in FIG. 9 includes shaft sections **85** and **86** secured together through a cylindrical liner **87** on which are mounted multiple tubes **88** arranged in the same manner as shown in FIG. 2 and having their inner end faces ground to a frustoconical configuration complementary to that of the shell filling **81**. Preferred results are obtained with a refiner of this construction if the inlet and outlet connections are arranged to cause the stock to flow from the plug to the shell, but otherwise the mode of operation of this unit is comparable to those already described in connection with FIGS. 1–8.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a plug mounted for rotation in one end of said shell and including means forming a plurality of enclosed passages extending generally axially therethrough, said passages being arranged throughout the body of said plug in a plurality of generally concentric rows with respect to the axis of said plug and in closely spaced relation both radially and circumferentially of said axis to provide the axially inner end of said plug with a surface of generally honeycomb pattern defining the axially inner ends of said plug passages and forming a corresponding plurality of annular working edges, means in said shell forming a working surface arranged in facing relation with said working edges of said plug and having passages therein providing for flow of stock therethrough, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said passages in said plug, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

2. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a frustoconical plug mounted for rotation in one end of said shell and including means forming a plurality of enclosed passages extending generally axially therethrough, said passages being arranged throughout the body of said plug in a plurality of generally concentric rows with respect to the axis of said plug and in closely spaced relation both radially and circumferentially of said axis to provide the axially inner end of said plug with a surface of generally honeycomb pattern defining the axially inner ends of said plug passages and forming a corresponding plurality of annular working edges, means in said shell forming a frustoconical working surface arranged in facing relation with said working edges of said plug and having passages therein providing for flow of stock therethrough, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said passages in said plug, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

3. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a frustoconical plug mounted for rotation in one end of said shell and including means forming a plurality of enclosed passages extending generally axially therethrough, said passages being arranged throughout the body of said plug in a plurality of generally concentric rows with respect to the axis of said plug and in closely spaced relation both radially and circumferentially of said axis to provide the axially inner end of said plug with a surface of generally honeycomb pattern defining the axially inner ends of said plug passages and forming a corresponding plurality of annular working edges, means including a plurality of generally axially extending bars in said shell forming a frustoconical working surface arranged in facing relation with said working edges of said plug and having passages therein providing for flow of stock therethrough, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said passages in said plug, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

4. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a plug mounted for rotation in one end of said shell and including means forming a plurality of enclosed passages extending generally axially therethrough, said passages being arranged throughout the body of said plug in a plurality of generally concentric rows with respect to the axis of said plug and in closely spaced relation both radially and circumferentially of said axis to provide the axially inner end of said plug with a surface of generally honeycomb pattern defining the axially inner ends of said plug passages and forming a corresponding plu-

rality of annular working edges, means in said shell forming a plurality of enclosed passages extending generally axially therethrough, said shell passages being arranged in a plurality of generally concentric rows and in closely spaced relation both radially and circumferentially over substantially the same cross-sectional area of said shell as said plug passages to provide a generally honeycomb pattern defining the axially inner ends of said shell passages and forming a corresponding plurality of annular working edges opposed to said working edges of said plug, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said passages in said plug and shell, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

5. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a frustoconical plug mounted for rotation in one end of said shell and including means forming a plurality of enclosed passages extending generally axially therethrough, said passages being arranged throughout the body of said plug in a plurality of generally concentric rows with respect to the axis of said plug and in closely spaced relation both radially and circumferentially of said axis to provide the axially inner end of said plug with a surface of generally honeycomb pattern defining the axially inner ends of said plug passages and forming a corresponding plurality of annular working edges, means in said shell forming a plurality of enclosed passages extending generally axially therethrough, said shell passages being arranged in a plurality of generally concentric rows and in closely spaced relation both radially and circumferentially over substantially the same cross-sectional area of said shell as said plug passages to provide a generally honeycomb pattern defining the axially inner ends of said shell passages and forming a corresponding plurality of annular working edges opposed to said working edges of said plug, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said passages in said plug and shell, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

6. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a generally cylindrical plug mounted for rotation in one end of said shell on the central axis thereof and including means forming a plurality of enclosed passages extending generally axially therethrough, said passages being arranged throughout the body of said plug in a plurality of generally concentric rows with respect to the axis of said plug and in closely spaced relation both radially and circumferentially of said axis to provide the axially inner end of said plug with a surface of generally honeycomb pattern defining the axially inner ends of said plug passages and forming a corresponding plurality of annular working edges, means in said shell forming a plurality of enclosed passages extending generally axially therethrough, said shell passages being arranged in a plurality of generally concentric rows and in closely spaced relation both radially and circumferentially over substantially the same cross-sectional area of said shell as said plug passages to provide a generally honeycomb pattern

defining the axially inner ends of said shell passages and forming a corresponding plurality of annular working edges opposed to said working edges of said plug, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said passages in said plug and shell, each of said ports being proportioned for continuous direct communication with all of the adjacents ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

7. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite cnds thereof, a plug mounted for rotation in one end of said shell and including a plurality of tubes secured together in generally parallel relation with the axis of rotation thereof and in substantially contiguous relation both circumferentially and radially of said axis to form the body of said plug with the inner ends of said tubes forming a corresponding plurality of annular working edges defining a generally honeycomb pattern, means in said shell forming a working surface arranged in facing relation with said working edges of said plug and having passages therein providing for flow of stock therethrough, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said tubes in said plug, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

8. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a frustoconical plug mounted for rotation in one end of said shell and including a plurality of tubes secured together in generally parallel relation with the axis of rotation thereof and in substantially contiguous relation both circumferentially and radially of said axis to form the body of said plug with the inner ends of said tubes forming a corresponding plurality of elongated annular working edges defining a frustoconical generally honeycomb pattern, means in said shell forming a frustoconical working surface arranged in facing relation with said working edges of said plug and having passages therein providing for flow of stock therethrough, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said tubes in said plug, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

9. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a plug mounted for rotation in one end of said shell and including a plurality of tubes secured together in generally parallel relation with the axis of rotation thereof and in substantially contiguous relation both circumferentially and radially of said axis to form the body of said plug with the inner ends of said tubes forming a corresponding plurality of annular working edges defining a generally honeycomb pattern, said shell including a plurality of tubes secured together in generally parallel relation with said

plug tubes and in substantially contiguous relation both circumferentially and radially of said plug axis over substantially the same cross-sectional area of said shell as said plug tubes to provide a corresponding plurality of annular working edges arranged in facing relation with said working edges of said plug in a similarly honeycomb pattern, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said tubes in said plug and shell, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

10. A rotary refiner of the character described for liquid slurry stock, comprising means defining a stationary shell having stock ports at opposite ends thereof, a frustoconical plug mounted for rotation in one end of said shell and including a plurality of tubes secured together in generally parallel relation with the axis of rotation thereof in substantially contiguous relation both circumferentially and radially of said axis to form the body of said plug with the inner ends of said tubes forming a corresponding plurality of elongated annular working edges defining a generally honeycomb pattern, said shell including a plurality of tubes secured together in generally parallel relation with said plug tubes in substantially contiguous relation both circumferentially and radially of said plug axis over substantially the same cross-sectional area of said shell as said plug tubes to provide a corresponding plurality of elongated annular working edges arranged in frustoconical complementary relation with said working edges of said plug in a similarly honeycomb pattern, means for connecting supply and discharge lines for stock to said ports to provide for flow of stock between said ports by way of said tubes in said plug and shell, each of said ports being proportioned for continuous direct communication with all of the adjacent ends of said plug or shell passages respectively for continuous flow of stock through the outside passages, and means for rotating said plug in said shell while the stock is flowing between said ports to cause continuous working of the stock between the relatively moving said working edges of said plug and shell.

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