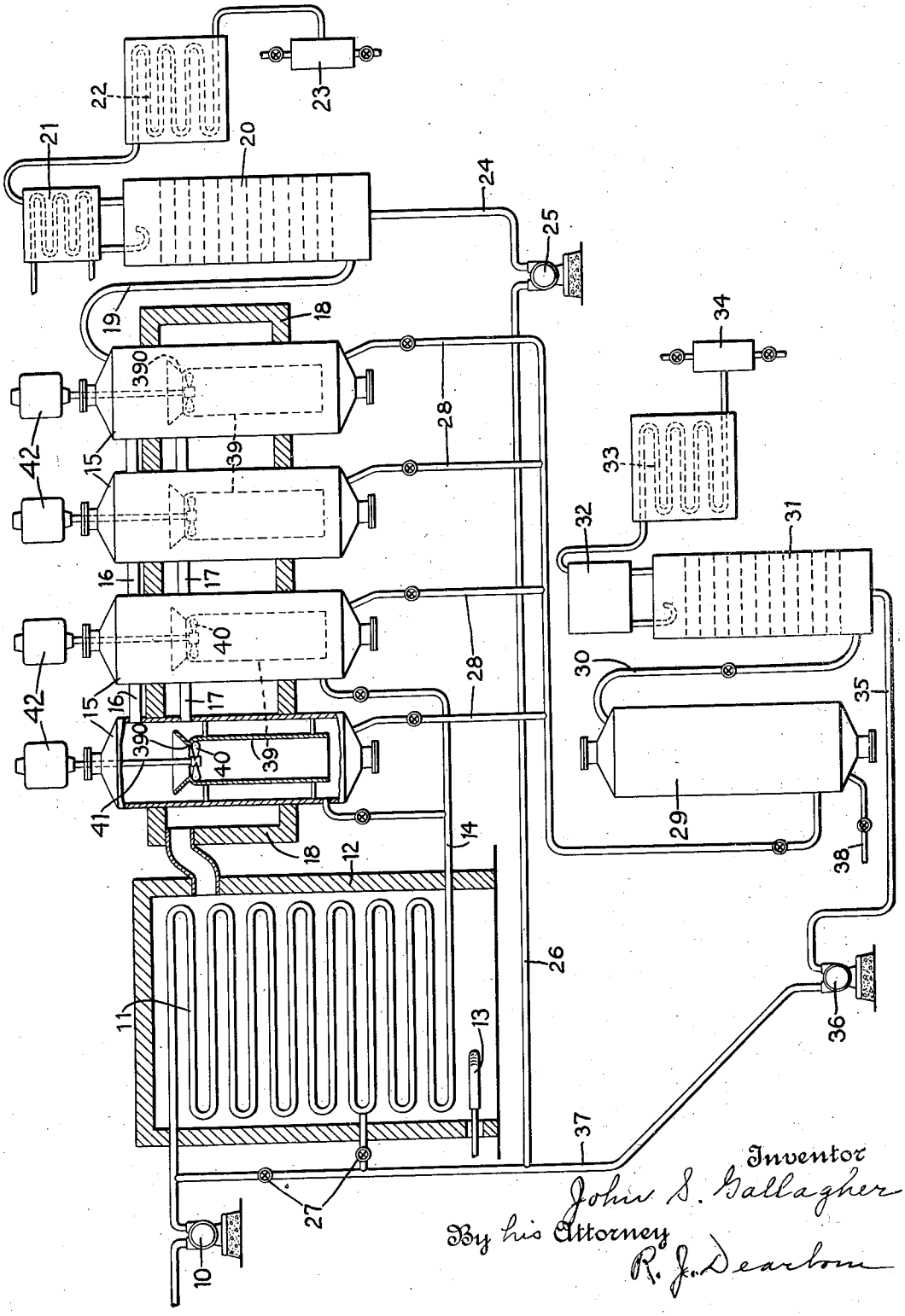
July 2, 1935. J. S. GALLAGHER 2,006,449

PROCESS AND APPARATUS FOR CRACKING OILS

Filed April 18, 1928



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Patented July 2, 1935 2,006,449

UNITED STATES PATENT OFFICE

2,006,449

PROCESS AND APPARATUS FOR CRACKING OILS

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Application April 18, 1928, Serial No. 270,820

12 Claims. (Cl. 196—68)

This invention relates to an improved process and apparatus for the conversion of heavier oils, having a relatively high boiling point, into lower boiling oils, such as the type commercially known as gasoline. Primarily, the invention has to do with the construction and mode of operation of the apparatus employed for the heating of the oil and maintaining it under the appropriate conditions to effect the desired conversion. It is a particular object of the invention to provide for a more even distribution of heat in the conversion zone, and a more efficient heat transmission condition in this zone, and also to prevent, to a large degree, the deposition of carbon which usually takest place in such zone and which is extremely detrimental.

While the invention is applicable to stills or conversion zones of practically every type, it is particularly applicable to a system commonly known as the coil and drum, in which the oil is first heated in its passage through a long, continuous coil in a furnace and is then introduced into one or more of a series of drums where the main process of conversion takes place. In systems of this character the oil is usually raised to a temperature somewhat above the initial cracking point or, say, between 750° and 850° F. in the coil and is maintained at this or only a slightly reduced temperature in the drum or series of stills. For this purpose the stills may either be heat-insulated or may receive heat from an external source. The amount of heat applied externally to the stills is necessarily small, or at least the introduction of heat must be brought about gradually, without the use of excessive temperatures, in view of the great danger which always accompanies the application of intense heat to a large body of oil under pressure. Deposition of carbon is bound to take place under operating conditions in common practice and due to its poor heat transmission qualities, hot spots, which tend to greatly weaken the shell of a still, are sure to develop wherever intense heat is applied. For this reason the temperature of the large body of oil in the drum, or series of stills, must be largely maintained by the heat of the incoming charge from the coil and the mild application of external heat. If no means were provided to assist in the transmission, through the body of oil, of heat coming from these sources, it would be extremely difficult to maintain uniform conditions in the stills, and particularly to maintain the desired temperature on the oil at the centers of the large bulks contained in the stills. Furthermore, it is now recognized that where an effort is made to heat a large body of liquid in a vessel such as a still by means of heated gases on the outside, there is a tendency to form a film of gases on one side of the shell of the vessel and a film of liquid on the inside and these films offer an excessively high resistance to the transmission of heat.

It is toward overcoming these difficulties, which have been encountered in the past, that the present invention is directed. To this end it is contemplated maintaining the oil within the drums or stills in rapid circulation in such a way that all of the oil will continually be in a state of movement and will pass from the inner to the outer portions of the stills and vice versa. This circulation of the oil, furthermore, is of such a nature as not to produce a centrifugal action, which would result in the objectionable separation of the heavier from the lighter constituents, but it is preferably of such velocity as to produce turbulence of the particles of oil in their circulation. The vigorous and rapid circulation of the oil, which is contemplated by the present invention, will not only serve to provide the desired even distribution of heat throughout the entire body of oil in the conversion zone, but will also prevent to a large degree the deposition of carbon, and will tend to break up or reduce the thickness of the liquid film on the inside wall of the still.

From the standpoint of greater heat transmission efficiency and better distribution, it becomes possible to maintain slightly lower temperatures in the hotter portions of the heating coil, which in the past have always been a source of trouble. It is well known that in a coil type of heater the tubes which go to make up the lower section of the coil are burned out more frequently than the upper tubes due to the excessive heat in the lower portion of the furnace and due to the tendency to deposit carbon in the lower tubes under the intense heat. A great advantage, therefore, is brought about by the possibility of using lower temperatures in the lower section of the coil due to the more uniform and efficient distribution of the heat in the drums or stills. Incidentally, the means which the present invention contemplates for the production of the rapid circulation of the oil within the drums is such as to apply additional heat to the oil in the stills by the conversion of the mechanical energy into heat and this action further enables the employment of more moderate temperatures for external application of heat to the stills. Obviously, if desired, the usual temperature conditions in the

coil and in the still furnace could be maintained and the greater efficiency in the transmission and distribution of the heat could be utilized to produce a higher temperature of the oil in the stills with a consequent higher rate of conversion. It has been determined by experimentation that the rate of conversion under temperatures in the neighborhood of 300° F. is doubled for each increase of 22° in the temperature of the oil so that material benefit is derived from the improved heating conditions.

Now, as already suggested, the rapid circulation of the oil has the further advantage of tending to keep in suspension the tarry residues or particles of carbon which would otherwise tend to settle out at the bottoms of the stills, or to deposit on the walls of the stills, and thus cake up and prevent proper heat transmission. This feature is particularly advantageous where a series of interconnected drums are employed. In systems of this character it is commonly the practice to provide for the passage of the oil from one still into the next by means of a line just below the liquid level of the oil in the stills. Fresh oil from the coil is introduced continuously into the bottom of the first still, or perhaps of the first two stills, so that a slight circulation is brought about in these. However, there is a tendency to accumulate more or less of a stagnant pool of oil in the remaining drums of the series. This then leads to a condition of over-cracking of those portions of the oil which remain in the stills for an undue length of time with the result that an excessive amount of carbon is formed. While the occasional withdrawal of the bottoms or tarry residues from all of the stills will tend to alleviate this condition, it is by no means as satisfactory as the provision of positive means for circulating the oil within each still. When such means are employed, the oil which passes from one still into the next, through the liquid levelling lines toward the tops of the stills, will be representative of the entire body of oil in the still from which it flows. This will naturally tend to effectively bring about the maintenance of successively heavier mixtures of oil in the drums from the first to the last. Most of the objectionable tarry residues may in this way be forced into the last drum of the series and it will be possible to provide for the continuous withdrawal of these residues from this still. There will be no tendency to clog up the passageway by means of the coky and tarry deposits, since these constituents will be held in suspension in the somewhat lighter residual oil up to the time of withdrawal from the still. While this may lead to the removal of some of the lighter oil which could possibly be retained for further cracking, the advantage derived from the uniformity of operation clearly over-balances this objection.

Under the practice now commonly followed, this uniformity of operation is not possible since residues must, as a rule, be drawn off occasionally from all of the stills and for this reason, as well as to prevent the clogging of the tar-drawing lines by virtue of the heavy tars which ordinarily collect in the bottoms of the stills, the drawing of tar can usually only be brought about at intermittent periods and not continuously. An objection of this older method of operation is that it produces a shock on the system and in the further treatment of these tarry residues in some suitable tar stripping unit for the removal of the fractions which may be recycled into the system, the load on the tar stripper is continually fluctuating and it is impossible to maintain any uniformity in the output of the latter. However, where it is possible to continually withdraw a stream of residue from a single one of the battery of stills, as in accordance with the present invention, it is a simple matter to maintain uniform operating conditions on the tar stripping unit. This results in the production of a recycle stock which is of uniform consistency and which may be more readily handled directly in the same cracking operation. At the same time the elimination of the shock on the main stills, which normally occurs at tar drawing periods, serves to improve the operation of the entire system.

It will be apparent from the foregoing that through the application of the present invention, a more constant product will result and the length of continuous runs between periods of shut-down will be greatly increased.

With these and other incidental objects and advantages in view, one suitable form of the invention will now be described in detail, with reference to the accompanying drawing which forms a part hereof.

The single figure of the drawing illustrates diagrammatically an illustrative form of apparatus which may be employed for the conduct of the novel process.

Referring to the drawing, a pump **10** is provided for the purpose of drawing oil from any suitable source, and of any suitable character for cracking, and for forcing this oil in a stream through a heating coil **11**. This coil is located in a furnace **12** which may be heated by any suitable means, such as an oil or gas burner **13**. After the oil has been heated under pressure to a point slightly above a cracking temperature, it may be passed by the transfer line **14** into one or more of a series of drums or stills **15**. If desired, only a single drum need be employed, although it is regarded as preferable to employ a plurality of, say, three or four. Suitable vapor lines **16** and liquid lines **17** serve to connect the drums in series so that the generated vapors and the liquid body of oil may be passed successively from one drum to the other. If desired, the stills may merely be heat-insulated, although it is regarded as preferable to mount them in a suitable furnace **18**, which is adapted to apply heat externally to the mid-portions of the stills. Vapors of lower boiling oils, which are generated in the several stills, may be conducted by a vapor line **19** to a dephlegmator or fractionating tower **20**, which may be of any suitable construction and may, for example, be a bubble tower. A portion of the vapors will be condensed in this tower but those which persist in vapor form will pass out at the top into a refluxing condenser **21** and some will continue to the final condenser **22** and the storage receptacle **23**. The condenser **21** may either be air-cooled or cooled by some liquid medium. Preferably it will be employed as a heat exchanger for the purpose of raising the temperature of the fresh charge before the latter is introduced into the coil **11**.

From the base of the fractionating tower, a line **24** will serve to conduct those portions of the original vapors which have been condensed therein to a pump **25**, which is connected by a line **26** to the coil **11**. The condensate which is recycled in this way may either be introduced into the upper end of the coil **11**, together with the fresh charge, or may be introduced at a lower point where its temperature corresponds more nearly to that of the charge. Suitable valves

27 may be provided for controlling the introduction of this condensate.

Tar draw-off lines 28 are provided from the base portions of each of the stills 15 to permit the withdrawal, from time to time, of the heavy residual oil which may tend to collect at the base of these stills. In the actual operation of the apparatus, when provided with the circulating means of the present invention, it will normally only be required to withdraw the tar from the last of the series of stills and this may be done more or less continuously. The residues so withdrawn may be passed into an expansion chamber or auxiliary still 29 wherein the pressure will be materially reduced and a large portion of the residues will be vaporized under the lower pressure. Vapors so generated may be led through a line 30 to a dephlegmator or fractionating column 31 which may be provided at the top with a suitable refluxing condenser 32, from which the vapors may be passed to a final condenser 33 and collection receptacle 34. The heavier portions of the vapors generated in the still 29 will be condensed in the dephlegmator 31 and may be passed by a line 35, pump 36 and line 37 to some suitable point in the main cracking system; for example, the line 37 may join the line 26 so that condensates from the two dephlegmators 29 and 31 may be handled together. The heavy tars which collect in the base of the chamber 29, and are not volatilized under the reduced pressure, may be withdrawn through a line 38 and sent to suitable storage, or, if desired, may be further treated by a process of steam distillation or the like.

All of the features which have been described in detail in the foregoing sections are matters of more or less known practice, and they are set forth here merely for the purpose of better indicating the nature and utility of the novel features which are contemplated by the present invention and which will now be described. It will be understood that the features to be described serve to improve the operation of the foregoing system and make it more practicable to operate in the manner indicated.

Within each of the stills 15 there is provided a long, tubular shell 39 which serves to divide each still into an inner and outer channel. These shells may be of any suitable dimension, but preferably will have a diameter of substantially more than half of the inside diameter of the stills. At their tops, these shells will preferably be flared slightly and directly below the flared portion, they will preferably be provided with a slight restriction in the passageway, as indicated at 390. They will be suitably supported by angle members, or the like, within the stills so as to have their upper ends slightly below the liquid level and their lower ends some distance above the bottoms of the stills.

A propeller blade 40 is mounted in the upper end of each of the shells, just below the restricted portion 390, and is supported by a rotatable shaft 41. These propellers have a dimension from tip to tip which is slightly less than the inside diameters of the shells. It will be understood that the shafts 41 are passed through suitable stuffing boxes in the upper ends of the stills to prevent leakage of the vapors and at their upper ends they are connected in any suitable way to driving motors 42. If desired, a single motor, together with suitable gearing and other connections, might be provided to drive all of the shafts but the use of individual motors is deemed preferable.

In the operation of the system, the body of oil maintained in each of the stills will be kept in constant circulation by means of the propellers 40. The action of the latter is to suck in the upper portions of the oil through the upper flared ends of the shells 39 and to force the oil downwardly through the shells and out at the bottoms of the latter. This oil will then necessarily be forced upwardly through the passageway between the shells and the inner walls of the stills and will be returned for circulation in the same way. By providing shells of the appropriate diameter, the speed of the oil in passing through the channels between the shells and the inner walls of the stills may be raised to any extent desired. It will be clear, therefore, that by the use of this system there will be brought about a very rapid circulation of the oil to distribute the heat of the incoming charge, as well as that externally applied through the walls of the stills to all portions of the oil, and, furthermore, the rapid movement of the oil will not only bring about more efficient heat transmission, due to partly breaking up the liquid film on the inside of the still walls, but will prevent deposition of carbon or tarry matter, particularly on these walls.

As a further aid to the transmission of heat from the gases on the outside of the stills to the liquid within, the protective or heat insulating film of gases which forms on the outer surfaces of the stills may be broken up in any suitable way by the provision of mechanical agitating devices or means for directing the gases in such a manner as to effect the desired result.

Without intending to restrict the scope of the invention in any way, some suitable figures concerning the construction and method of operation of the system may here be suggested as illustrative. The stills 15 may have a diameter of, say, 5 feet and be provided with shells 39 having a diameter of 4 feet, thus leaving an annular space of, say, 6 inches in width. The propellers 40 may have an overall dimension of, say, 40 inches and may be driven at a speed between 300 and 1200 R. P. M., although speeds outside of this range may be permissible. It is contemplated that the displacement of the oil will be such as to provide a velocity of from 10 to 15 feet per second through the annular passageway between the shell 39 and the wall of the still. This velocity should be sufficient through the relatively narrow channel to produce a state of turbulence of the oil so that it will become completely intermixed and will no longer flow in regular, well defined layers or streams. In this way the breaking up of the film of oil adjacent the wall of the still will be quite effectively brought about. Preferably the main conversion units will be operated under pressures of between 100 and 500 pounds, while the tar stripping unit may be operated at a pressure only slightly above atmospheric. Upon leaving the coil 11, the oil may have a temperature of between 750° and 875° F., preferably 825° F., and in the stills 15 this temperature should be substantially maintained, although a drop of, say, 25° may be permitted.

While one admirable form of the invention has been described in detail, and certain specific figures have been given, it will be understood that the invention is capable of many modifications and is applicable to a wide variety of operating conditions. It is not desired to be limited in its

application other than by the scope of the claims which follow:

What I claim is:

1. In apparatus for converting higher boiling hydrocarbons into lower boiling ones, a cylindrical still adapted to contain a body of oil, a cylindrical shell disposed within the still adapted to divide the latter into a relatively large inner channel and a relatively narrow annular passageway between said shell and still, the cross sectional area of the inner channel being relatively larger than that of the annular passageway, a propeller mounted within the inner channel arranged for circulating oil through the inner and the annular channels at a rate sufficient to create turbulent flow in the annular passageway next to the wall of the still, and means for applying a heating medium to the exterior of the wall of the still adjacent the annular passageway.

2. In apparatus for converting higher boiling hydrocarbons into lower boiling ones, a heating coil adapted to heat oil in transit to a cracking temperature under superatmospheric pressure, a cylindrical still adapted to contain a body of oil at cracking temperatures under superatmospheric pressure, a transfer line adapted to conduct oil from the heating coil to the still, a cylindrical shell disposed within the still adapted to divide the latter into a relatively large inner channel and a relatively narrow annular passageway between said shell and still, the cross sectional area of the inner channel being relatively larger than that of the annular passageway, a propeller mounted within the inner channel arranged for circulating oil through the inner and the annular channels at a rate sufficient to create turbulent flow in the annular passageway next to the wall of the still, and means for applying a heating medium to the exterior of the wall of the still adjacent the annular passageway.

3. In apparatus for converting higher boiling hydrocarbons into lower boiling ones, a plurality of cylindrical stills adapted to contain bodies of oil at cracking temperatures under superatmospheric pressure, liquid and vapor lines interconnecting the stills in series, a cylindrical shell disposed within each still adapted to divide each still into a relatively large inner channel and a relatively narrow annular passageway between the shell and still, the cross sectional area of the inner channels being relatively larger than that of the annular passageways, propellers mounted within the inner channels arranged for circulating oil through the inner and annular channels at a rate sufficient to create turbulent flow in the annular passageways next to the walls of the stills, and means for applying a heating medium to the exterior of the walls of the stills adjacent the annular passageways.

4. In apparatus for converting higher boiling hydrocarbons into lower boiling ones, a heating coil adapted to heat oil in transit to a cracking temperature under superatmospheric pressure, a plurality of cylindrical stills adapted to contain bodies of oil at cracking temperatures under superatmospheric pressure, a transfer line adapted to conduct oil from the heating coil to one of the stills, liquid and vapor lines interconnecting the stills in series, a cylindrical shell disposed within each still adapted to divide each still into a relatively large inner channel and a relatively narrow annular passageway between the shell and still, the cross sectional area of the inner channels being relatively larger than that of the annular passageways, propellers mounted within the inner channels arranged for circulating oil through the inner and annular channels at a rate sufficient to create turbulent flow in the annular passageways next to the walls of the stills, and means for applying a heating medium to the exterior of the walls of the stills adjacent the annular passageways.

5. The process of continuously producing gasoline and other light oils from charging stock comprising heavier hydrocarbons, which consists in continuously heating such charging stock at a cracking temperature in a closed still; supplying during the run additional charging stock to the still; continuously taking off vapors; rejecting during the run part of the still contents; and forcing the entire liquid contents of the still therethrough under the action of circulating means adapted to create and translate whirling vortex effects into a positive driving force whereby such high velocity is obtained that the conditions throughout such still contents are, as to temperature and composition, so nearly identical that variation as to these characteristics in different parts of the still approaches the zero or vanishing point.

6. The process of continuously producing gasoline and other light oils from charging stock comprising heavier hydrocarbons, which consists in continuously heating such charging stock at a cracking temperature in a closed still; continuously supplying additional charging stock to the still; continuously taking off vapors; withdrawing during the run a portion of the still contents; and mechanically effecting such a turbulent and rapid circulation of the entire liquid contents of the still that the conditions of temperature and composition are so nearly identical throughout said still that variation as to these characteristics approaches the zero or vanishing point.

7. The process of cracking heavier hydrocarbons into lighter hydrocarbons which includes continuously flowing a stream of said heavier hydrocarbons to and from a cracking zone under pressure; extraneously heating a portion of said cracking zone; continuously releasing vaporized hydrocarbons therefrom; and maintaining such a positive and rapid circulation of the hydrocarbons throughout the entire cracking zone independently of the stream of hydrocarbons flowing to and from said cracking zone that variation in conditions of temperature and dispersion of solids throughout the entire cracking zone approaches the zero or vanishing point.

8. In an oil cracking still having a circulating passage for the oil undergoing cracking, a propeller having blades operating in said passage, a tapered means in said passage immediately above the propeller for directing oil toward the center of said blades and a rim surrounding said blades and in close proximity to the walls of said passage for preventing slippage of oil from said propeller blades back along the walls of said passage.

9. In an oil cracking still having a circulating passage for the oil undergoing cracking, a propeller having blades operating in said passage, a rim surrounding said blades for preventing slippage of oil from said blades back along the walls of said passage, and a deflecting cone overlying said rim for facilitating the flow of oil into said blades.

10. In an oil cracking still having a circulating passage for the oil undergoing cracking, a propeller having blades operating in said passage, a tapered means associated with said passage im-

mediately above the propeller for directing oil toward the center of said blades, and a ring closely surrounding said blades for preventing slippage of oil from said propeller blades back along the walls of said passage.

11. In an oil cracking still having a circulating passage for the oil undergoing cracking, a propeller having blades operating in said passage, a ring closely surrounding and coacting with said blades for preventing slippage of oil from said blades back along the walls of said passage, and a deflecting cone overlying said ring for facilitating the flow of oil into said blades.

12. In an oil cracking still having a circulating passage for the oil undergoing cracking, a propeller having blades operating in said passage, and a tapered restriction associated with said passage immediately above the propeller for directing oil toward the center of said blades, the outer edge of said propeller being in close proximity to the walls of said passage and underlapping the said tapered restriction to prevent slippage of oil from said propeller blades back along the walls of said passage.

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