F. W. HARRIS.

APPARATUS FOR DEHYDRATING PETROLEUM EMULSIONS.

APPLICATION FILED JUNE 19, 1919.

1,405,119. Patented Jan. 31, 1922.

2 SHEETS—SHEET 1.

Fig. 1.

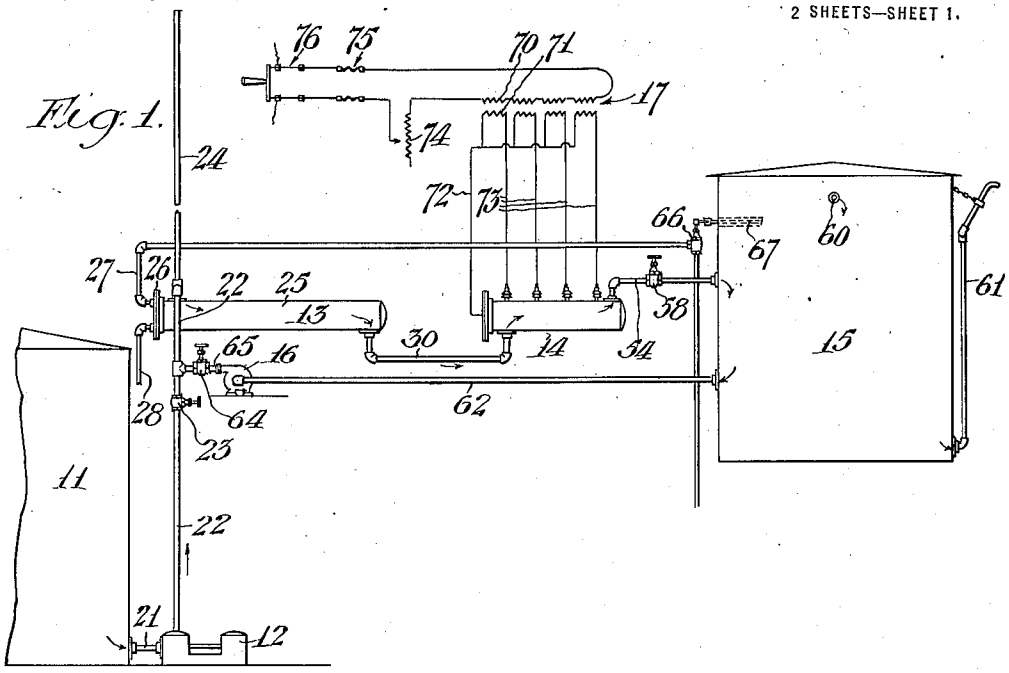
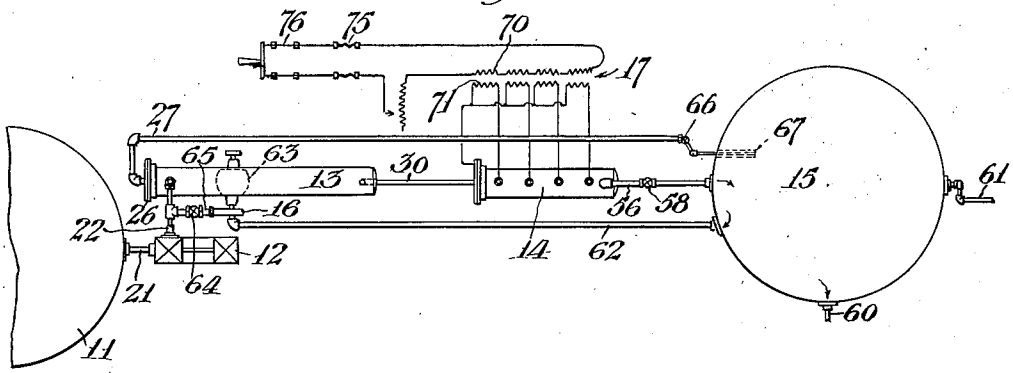


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

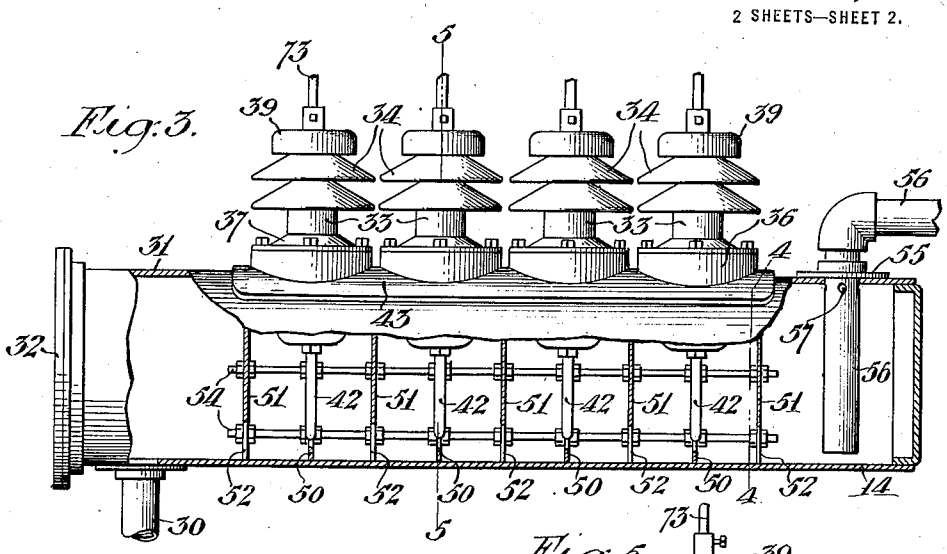


Fig. 5.

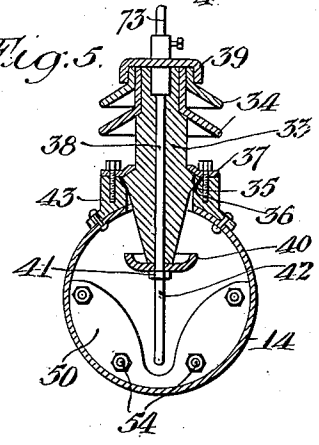


Fig. 4.

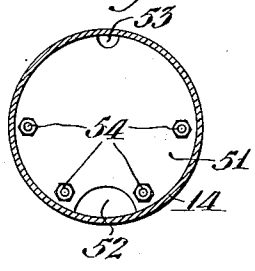


Fig. 6.

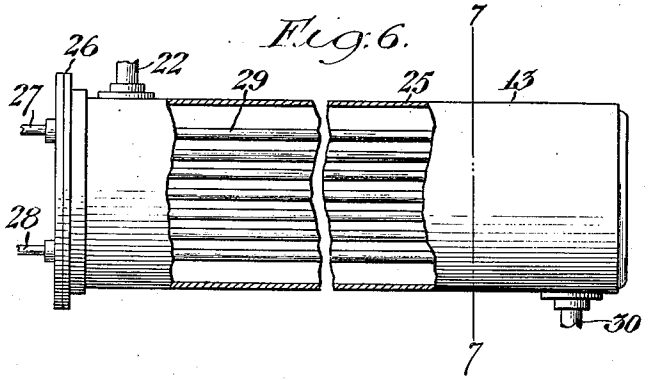
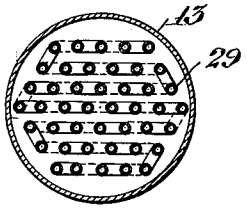


Fig. 7.



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UNITED STATES PATENT OFFICE.

FORD W. HARRIS, OF LOS ANGELES, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO PETROLEUM RECTIFYING COMPANY, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

APPARATUS FOR DEHYDRATING PETROLEUM EMULSIONS.

1,405,119. Specification of Letters Patent. Patented Jan. 31, 1922.

Original application filed February 6, 1918, Serial No. 215,717. Divided and this application filed June 19, 1919. Serial No. 305,446.

To all whom it may concern:

Be it known that I, FORD W. HARRIS, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Apparatus for Dehydrating Petroleum Emulsions, of which the following is a specification.

My invention relates to the art of separating water from petroleum oil with which it is commonly found associated in the form of an emulsion. It is a well known fact that many oil wells produce an emulsion of oil and water and that in many cases the water is present in the form of infinitesimal globules floating in the oil. It is further well known that by subjecting the emulsion to the action of an electric current that the small water particles agglomerate into large masses of free water and that said large masses may be readily separated from the oil by gravity.

In practicing the art of electrical dehydration it is found that on very heavy oils, for example oils of from nine to sixteen degrees Baumé and indeed on even lighter oils that it is desirable and in some cases necessary to heat the oil for the purpose of assisting in the coalescence of the water globules under the action of the electric current and for the further purpose of expediting the separation of the large masses of free water from the body of the oil. In all forms of electrical dehydrators with which I am familiar, the oil, while being subjected to the electric current, is carried in open vessels in which the treating electrodes are suspended. As a consequence, if the oil is heated to a degree best suited to the electrical treatment, the light vapors are driven off into the outer air with a consequent loss of value. More important, however, the light vapors mix with air in the top of the open vessel forming highly explosive and inflammable mixtures. During the passage of the electric current through most emulsions a portion of the oil is vaporized and the vapors so produced rise into the space in the top of the vessel and help form the inflammable mixture above referred to. As the vapors produced by the passage of the current are often very hot they may be hot enough to ignite when they reach the top of the containing vessel or a stray electric discharge may ignite them. When ignited they cause an explosion and it is common in plants of this nature to have dangerous and disastrous fires and explosions.

The objects of my invention are as follows:

First: To provide an apparatus in which the emulsion, while being subjected to the action of the electric current, may be heated considerably above the boiling point of the lighter constituents thereof without danger of fire.

Second: To provide means for holding the emulsion under considerable pressure during its electrical treatment so that the formation or vaporization of light vapors is retarded or entirely prevented.

Third: To provide means for setting up and maintaining intensified electric fields and for insuring the passage of the emulsion therethrough.

Fourth: To provide means for preventing the accumulation of free water masses in these fields.

Fifth: To provide means for regulating the character of the mixture being treated regardless of the character of the emulsion being treated.

Further objects and advantages will be set forth further hereinafter.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a side elevation, largely diagrammatic, of an apparatus adapted to carry on my invention.

Fig. 2 is a plan of the same, the electrical features being partly omitted.

Fig. 3 is a side elevation of a treater, a portion of the shell being partly broken away and shown in central section for the purpose of better illustrating my invention.

Fig. 4 is a section on a plane indicated by the line 4—4 of Fig. 3.

Fig. 5 is a section on a plane indicated by the line 5—5 in Fig. 3.

Fig. 6 is a side elevation, partly in section, of a preferred form of heater.

Fig. 7 is a section on a plane indicated by the line 7—7 of Fig. 6.

The apparatus shown in Fig. 1 consists broadly of a supply tank 11, a supply pump

12, a heater 13, a treater or dehydrator 14, a settling tank 15, a circulating pump 16, and certain electrical apparatus 17.

The supply tank 11 may be of any form or in some cases may be dispensed with, the supply pump 12 in any case taking emulsion in through a pipe 21 and forcing it through a pipe 22 and a valve 23 into the heater 13. The pipe 22 passes upwardly and over the heater 13 being connected into the top thereof. A stand pipe 24 is connected into the pipe 22, the upper end of the pipe 24 being open. The object of this arrangement is to prevent the heater 13 and the treater 14 from being drained by a back flow through the pipe 22 in the event of a leak or other opening developing in such a manner as to allow such a flow. By carrying the pipe 22 to a higher level than the top of the heater 13 and the treater 14 and venting the highest point in the pipe 22 to the air through the pipe 24, the pipe 22 below the point of connection to the pipe 24 can be entirely emptied without siphoning liquid from the heater 13. Also if the pump 12 for any reason is pumping air this air flows upwardly and escapes from the end of the pipe 24 which is sufficiently long to provide a static head which will balance the highest pressure in heater 13. It is extremely important to keep air out of the treater 14 and by making the outlet pipe 56 and the inlet pipe 22 connect into the extreme top of the treater 14 and the heater 13 respectively and by venting both to the air, the first through the tank 15, and the latter through the pipe 24, the draining of the heater 13 and treater 14 is prevented. Also by providing the pipe 24 the inadvertent introduction of air to the treater 14 is prevented. By absolutely excluding air from the apparatus an explosion, due to the ignition of hot gases in the treater, is rendered impossible.

The heater 13 may be of any of a large number of forms, that shown consisting of a tight shell 25 having a head 26 through which a steam inlet pipe 27 and a steam outlet pipe 28 pass, these pipes being connected to either end of a heating coil 29 inside the shell. The emulsion delivered by the pipe 22 passes through the shell 25 in intimate contact with the heating coil 29. The heated emulsion is delivered by a pipe 30 from the heater 13 to the treater 14.

The treater 14 consists of a tight shell 31 having a removable head 32 at one end. Secured in gas tight relationship in the top of the shell 31 is a plurality of porcelain insulators. Each of these insulators shown in Fig. 5 consists of a central core 33 of porcelain to which is cemented one or more porcelain petticoats 34. The core 33 has a central flange 35 which is clamped between a ring 36 and a series of clamps 37, the flange 35 resting on elastic packing so that it makes a gas tight joint with the ring 36. A central conducting rod 38 passes through the center of the core 33 being threaded into a metal cap 39 cemented to the top of the insulator, the rod 38 being cemented into the core 33 so as to form a gas tight joint therewith. A deflector disk 40 formed of insulating material is clamped against the bottom of the core 33 by a nut 41. The rod 38 has an extension below the nut 41 hereinafter called the live electrode 42. The parts 33 to 41 inclusive serve to support the live electrode 42 inside the shell 31 and to allow electrical connection to be made thereto through the shell 31. Obviously any mechanically equivalent structure which will accomplish this result may be used without departing from the spirit of my invention. The rings 36 are secured by suitable bolts to a casting 43 secured to the top of the shell 31.

Coacting with each of the live electrodes 42 is a grounded electrode 50. Each of these consists of a plate of material cut away so that the lower portion of the live electrode 42 is surrounded by the edge of the plate, the distance between the edge of the plate 50 and the live electrode 42 being increased as the plate flares away in passing upwardly as shown in Fig. 5. The plates or grounded electrodes 50 are in the same plane as the live electrodes 42.

Equally distant between the plates 50 and on either side thereof are diversion plates 51, the plates having an emulsion opening 52 at the bottom thereof and a gas opening 53 at the top thereof. A diversion plate 51 is best shown in Fig. 4. The plates 50 and 51 fit snugly inside the shell 31 and are spaced apart by bolts 54. It will be seen that the live electrodes 42 and their supporting parts can be lifted out by unbolting the rings 36 from the casting 43 and that the plates 50 and 51 can then be removed as a unit from the shell 31 by removing the head 32.

A flange 55 is secured in the top of the shell 31 and a pipe 56 is secured therein, this pipe extending very nearly to the bottom of the shell 31 and having one or more gas holes 57 therein just inside the top of the shell 31 as best shown in Fig. 3. A valve 58 is provided in the pipe 56 which discharges into the settling tank 15.

The settling tank 15 has a dry oil outlet pipe 60 near its top, a water outlet pipe 61 connected into its bottom and a circulating pipe 62 connected into an intermediate portion of the tank 15. The pipe 62 connects into the suction side of the circulating pump 16 which may conveniently be a centrifugal pump driven by a direct connected motor 63. A valve 64 is placed in a pipe 65 which connects the discharge

side of the pump 16 with the pipe 22 between the valve 23 and the heater 13. The steam pipe 27 may pass to a thermostatic valve 66 controlled by a thermostat 67 in the tank 15.

The electrical means 17 may well consist of a plurality of transformers each having a low tension primary 70 and a high tension secondary 71. One terminal of each of the secondaries 71 is connected to a ground wire 72 which in turn is connected to the shell 31 and the other terminal of each of the secondaries 71 is connected through a wire 73 with one of the caps 39 and through its rod 38 with one of the live electrodes 42. I find it convenient to connect all of the primaries 70 in a single series and to control the maximum current therethrough by an adjustable impedance 74. The primaries 70 may be protected by fuses 75 and connected to any suitable source of electric current through a switch 76. In practice I prefer to impress a potential of 11,000 volts between the electrodes 42 and 50 and an alternating potential of 440 volts is a convenient voltage to supply to the switch 76. The deflector disk 40 serves to force hot gases away from the core 33 and thus prevent flashovers thereon.

The method of operation of my invention is as follows:

The emulsion to be treated is delivered to the pipe 21 and forced by the pump 12 through the pipe 22 into the heater 13, the valve 23 being normally open and the valve 64 being normally closed. In the heater 13 the emulsion may be highly heated by live steam in the coil 29. The hot emulsion is then forced through the pipe 30 into one end of the shell 31. The first of the plates 51 preferably has no gas opening 53 so that all the emulsion passes through the opening 52. Since flowing liquids tend to travel in the shortest path the emulsion then flows towards the extreme bottom of the notch in the grounded electrode 50.

A very concentrated electric field is formed between the electrodes 42 and 50 and this field constantly forms disruptive discharges low down in the notch of the electrode 50. These discharges or arcs act on the oil and water to expand them, forming vapor and steam which tend to rise circulating the liquid and raising the arc with them. As the arcs rise they are forced to lengthen due to the peculiar configuration of the notch of the grounded electrode 50, one end of the arc running up the live electrode 42 and the other end following the plate 50 upwardly and outwardly. The potential between the electrodes 42 and 50 with no current flowing is determined by the ratio between the primary 70 and the secondary 71 and this potential is sufficient to cause a flow of current through the emulsion. If such a flow occurs on one electrode 42 and not on the others the potential on that electrode is greatly lowered and the potential on each of the others is increased due to the series connection of the primaries. This increase on the others results in another arc forming from another electrode 42 to electrode 50 and this in turn raises the potential still higher on the remaining two. With disruptive currents flowing from three of the electrodes 42 it will be found that probably three times normal potential will exist from the fourth electrode 42 to its corresponding electrode 50 until a disruptive current or arc is established therebetween. Once such a current flows between all four sets of electrodes it will ordinarily persist between all four sets behaving as follows. The arc in each set starts low down in the throat of the notch of the grounded electrode 50 and rises following the hot gases formed by the arc as they rise. As the arc rises it gets longer and the potential across it, that is between a live electrode 42 and a grounded electrode 50, increases until it is sufficient to establish a new arc in the throat when the long arc above ceases. The space between the electrodes 42 and 50 is then traversed by a succession of arcs each of which starts at the bottom of the electrode 42 and travels upwardly until it gets so long and unstable that a new arc starts below. The current flowing in each of the primaries 70 being the same due to their series connection, the current flowing between each pair of live and grounded electrodes tends to persist and remain equal to the current flowing between each other pair, the voltage between each pair varying to suit the conditions. I thus get a constant flow of current between each set of electrodes and a constant travel of the arcs through the body of the liquid being treated. This results in the rapid and complete agglomeration of water particles into large masses of free water leaving the oil free from emulsion.

During the travel of the liquid through the heater 13 and the treater 14 it is positively moved by the pump 12. The gas and vapor formed travel along the top of the shell 31 through the openings 53 and pass into the pipe 56 through the openings 57. The flow of liquid is along the bottom of the shell 31 through the openings 52. The pipe 56 extends to the bottom of the shell 31 so that it collects and carries away any free water that settles in the bottom of the shell 31 before carrying away any oil. The accumulation of water in the bottom of the shell 31 is thus prevented.

If desired the pump 12 may be used to build up pressure in the heater 13 and treater 14, the valve 58 being partially closed to control such pressure. In practice I prefer, however, to omit the valve 58 pumping

against a static head due to the fact that the pipe 56 enters the tank 15 considerably below the surface of the oil therein.

Ordinarily the emulsion is pumped through the heater 13 into the treater 14. The emulsion is broken in the treater 14 into free water and oil which pass into the tank 15 in which the water settles out and is withdrawn through the pipe 61, the cleaned oil being withdrawn through the pipe 60. In some cases in treating very stubborn emulsions I prefer to close the valve 23, open the valve 64 and use the pump 16 to circulate partially cleaned oil from the tank 15 through the heater 13 and treater 14. When I have obtained a tank 15 full of clean oil, I start the pump 12, open the valve 23 and regulate the valve 64 to supply a mixture of emulsion and partially cleaned oil to the treater 14. By so diluting the emulsion with partially cleaned oil I can control the percentage of moisture in the liquid in the treater 14 and thus handle emulsions of widely varying moisture content without adjustment of the voltage applied or the shape of the electrode 50. I have also found that by introducing into very fine emulsions, that is, emulsions in which the water is present in very fine particles, an emulsion in which large water globules are present that the work of dehydration is greatly facilitated. This I attribute to the fact that where the fine particles only are present that paths are formed which are truly conducting in the electrolytic sense but which are of such high resistance that the current density is very low and as a consequence these paths will carry current indefinitely without disrupting. By mixing with the fine emulsion a very much coarser one the resistance of the path is very greatly increased, the current flow is also increased and the path established is unstable.

Returning now to the objects of my invention as set forth in the preamble to this specification it will be seen that since the heater 13 and the treater 14 are closed vessels from which the air is excluded, I am able to heat the liquid above its boiling point and to subject it to violent electrical discharges without danger of explosions due to combination of the highly explosive gases so produced with oxygen. Moreover by making both the outlet and inlet to the treater 14 and heater 13 considerably higher than the tops of the treater 14 and heater 13 I am able to insure the exclusion of air therefrom. Moreover by discharging the liquid from the treater 14 at a point considerably below the surface of the treater liquid in the relatively cold tank 15 I am able to condense any gas carried in that liquid before it reaches the surface. Also by providing the pipe 24 I am able to discharge any air which may be delivered by the pump 12 to the pipe 22 so that it does not enter the heater 13.

Secondly, it will be seen that by the construction of my apparatus I am able to maintain some pressure on the fluids in the heaters 13 and the treater 14 so that gas formation is in a measure prevented.

Thirdly, it will be seen that due to the shape of the electrodes 42 and to the peculiar transformer connections used I am able to cause electric discharges in even very stubborn emulsions and to maintain and reestablish such discharges when they cease for any reason.

Fourthly, it will be seen that due to the small capacity of the treater 14 and its construction I am able to quickly dispose of any water that may accidentally get into the system.

Fifthly, it will be seen that I have provided means in the pipe 62 and the pump 16 for diluting the oil introduced so that its moisture content can be controlled.

This application is a division of application, Serial No. 215,717 filed by me on February 6, 1918.

I claim as my invention:

1. A dehydrator comprising a gas tight shell; means for introducing emulsion under pressure into said shell; an electrical conductor projecting through the wall of said shell; a live electrode situated inside said shell and connected to said conductor; insulation between said conductor and said shell, said insulation forming a gas tight joint between said conductor and said shell; means for impressing between said conductor and said shell, a voltage sufficient to cause a dehydration of the emulsion in said shell; and means for withdrawing treated oil and water from said shell.

2. A dehydrator comprising a gas tight shell; means for heating an emulsion; means for introducing said heated emulsion into said shell; an electrical conductor projecting through the wall of said shell; a live electrode situated inside said shell and connected to said conductor; insulation between said conductor and said shell, said insulation forming a gas tight joint between said conductor and said shell; means for impressing between said conductor and said shell, a voltage sufficient to cause a dehydration of the emulsion in said shell; and means for withdrawing treated oil and water from said shell.

3. A dehydrator comprising a gas tight shell; means for introducing emulsion under pressure into said shell; an electrical conductor projecting through the wall of said shell; a live electrode situated inside said shell and connected to said conductor; insulation between said conductor and said

shell, said insulation forming a gas tight joint between said conductor and said shell; means for impressing between said conductor and said shell a voltage sufficient to cause a dehydration of the emulsion in said shell; and means for withdrawing treated oil and water from the bottom of said shell.

4. A dehydrator comprising a gas tight shell; means for heating an emulsion; means for introducing said heated emulsion into said shell; an electrical conductor projecting through the wall of said shell; a live electrode situated inside said shell and connected to said conductor; insulation between said conductor and said shell, said insulation forming a gas tight joint between said conductor and said shell; means for impressing between said conductor and said shell, a voltage sufficient to cause a dehydration of the emulsion in said shell; and means for withdrawing treated oil and water from the bottom of said shell.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 12th day of June, 1919.

FORD W. HARRIS.