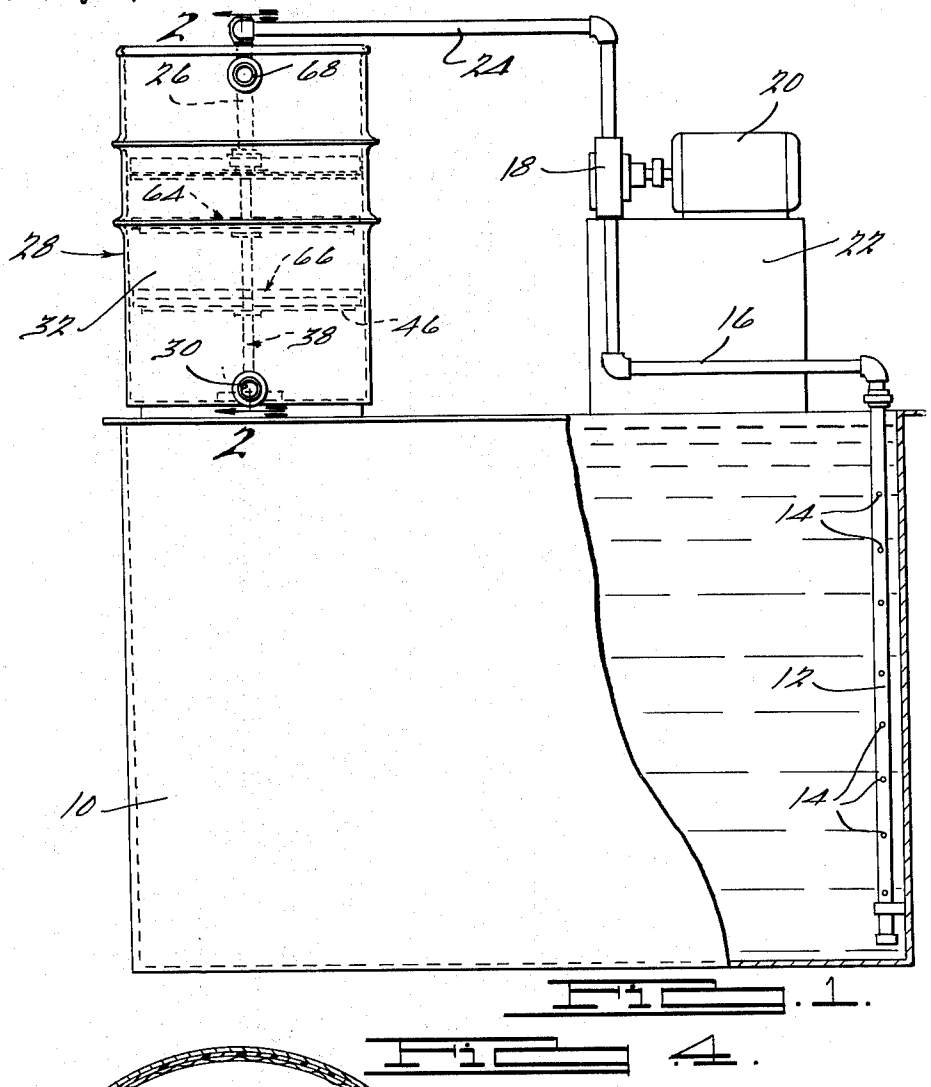
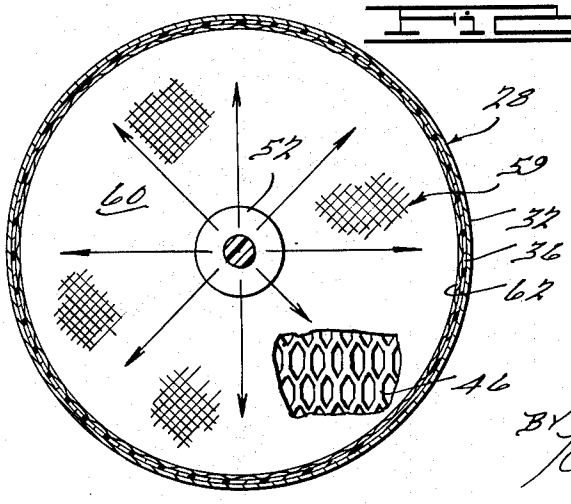
Dec. 7, 1965 R. J. CLAUSS ETAL 3,222,268

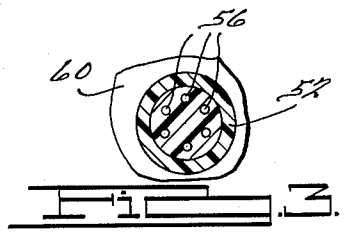
PARTICLE SEPARATOR DEVICE FOR PLATING BATHS

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4.



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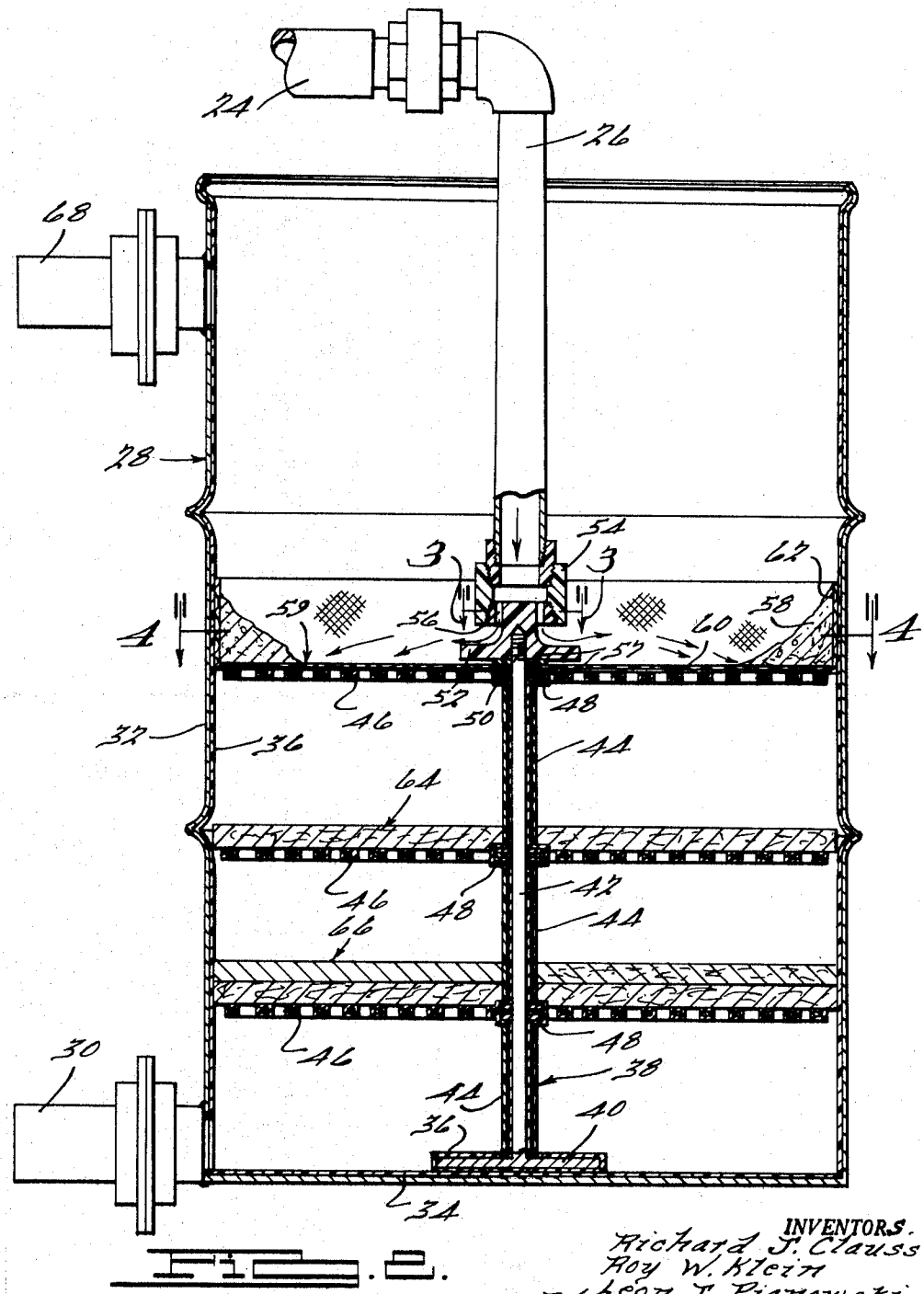


Fig. 2.

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PARTICLE SEPARATOR DEVICE FOR PLATING BATHS

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The present invention broadly relates to a mechanism for selectively separating extremely fine-sized particles and more particularly to a filtration device for filtering slurries having extremely fine-sized particles therein in order to remove any extraneous solids above a prescribed size range.

A large number of commercial processes employ slurries comprising a liquid incorporating extremely fine-sized insoluble particles suspended therethrough and which particles must be maintained within a controlled size range necessitating the removal of deleterious larger particles and other extraneous matter which is introduced into the slurry during its use. In many instances the progressive buildup in concentration of extraneous particles above a prescribed size range result in a substantial reduction in the efficiency and performance of the slurry eventually rendering it useless and it must therefore be discarded. This oftentimes represents a costly and time-consuming operation detracting from the overall efficiency of the process.

A typical example wherein slurries are employed is in the formation of satin-like high luster nickel plated finishes on base metals providing therewith a high degree of protection against corrosive attack and concurrently providing an attractive appearance. In electroplating operation of this type acidic aqueous slurries of a pH ranging from about 2 to about 6 of the Watts type employing conventional soluble nickel salts such as nickel sulfate, nickel chloride and nickel sulfamate, for example, and conventional brightener agents of the types well known in the art are provided with from about 10 grams up to about 500 grams per liter of extremely fine-sized particles generally having a particle size of less than about 5 microns and preferably less than about 2 microns and approaching colloidal dimensions. These particles are insoluble and are wetted by the acidic bright or semi-bright nickel plating solution. The fine-sized particles are suspended substantially uniformly through the bath and are incorporated in the layer of electro-deposited nickel on the surface of the base metal imparting thereto a satin-like finish.

The presence of extraneous larger size particles such as may result from poorly cast nickel anodes which powder during use and disperse coarse metallic particles of nickel and activated carbon in the bath result in the formation of non-uniform and coarse satin finishes. It has therefore become necessary to find a mechanism and method for economically removing such extraneous large size particles from the nickel bath and in other slurries having particles suspended therein of a controlled maximum size which is both efficient, economical and provides the desired degree of particle size selectivity.

It is accordingly a primary object of the present invention to provide an improved filtration apparatus for filtering slurries and selectively removing therefrom particles above a preselected size.

Another object of the present invention is to provide an improved filtration apparatus for removing solid particles greater than a predetermined size from a slurry which enables passage of all other solids below that specific size range and which apparatus is of simple design, economical

manufacture, durable operation and simple control, and which is quickly assemblable and disassemblable for cleaning and maintenance.

The foregoing and other objects of the present invention are achieved by providing a filtration apparatus comprising a receptacle having at least one substantially horizontal tier removably mounted therein of a filtering medium having a predetermined porosity enabling passage of a slurry therethrough which selectively removes extraneous particles above a preselected size.

Other objects and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a side elevation view of a typical liquid treating receptacle incorporating a filtration apparatus adjacent thereto which is constructed in accordance with the preferred embodiments of this invention;

FIG. 2 is a transverse vertical sectional view through the filtration apparatus shown in FIGURE 1 and taken substantially along the line 2—2 thereof;

FIG. 3 is a transverse horizontal view through the inlet nozzle and deflector of the filter apparatus shown in FIG. 2 and taken along the line 3—3 thereof, and

FIG. 4 is a transverse horizontal view through the filter apparatus above the top tier thereof as shown in FIG. 2 and taken substantially along the line 4—4 thereof.

Referring now to the drawings and as may be best seen in FIGURE 1, a typical self-contained installation of a filtration system mounted adjacent to a liquid receptacle or tank **10** is illustrated which is adapted to operate intermittently or continuously as desired, and to successfully remove solid particles in the slurry larger than a predetermined size but still enable the high solids content of smaller sized particles in the slurry having a size range broadly ranging from about 15 microns to a size approaching colloidal dimensions such as .1 micron to pass through and be recirculated back into the tank. The filtration system shown in FIGURE 1 is applicable to a wide variety of different slurries including aqueous alkaline or acidic slurries having high solid contents such as concentrations ranging from about 10 grams up to about 500 grams per liter.

The extremely fine-sized particles contained in the slurry can comprise any one of a number of solids including certain sulfates, carbonates, phosphates, oxalates, silicates, metallic oxides, carbides, silicides, nitrides, fluorides, sulfides, of a variety of metals including aluminum, magnesium, boron, calcium, strontium, barium, alkali metal earths, titanium, manganese, zirconium, iron, chromium, and the like. Substantially insoluble particles which are wetted by the acidic nickel plating solutions of a type employed for electrodepositing a satin-like nickel finish on the surfaces of a base metal include insoluble silicates of aluminum, magnesium, boron, calcium, strontium and barium, and mixed silicates of these metals, as well as certain sulfates, carbonates, phosphates, and oxalates of alkaline earth metals, barium, strontium, and calcium, as well as certain oxides, carbides, silicides, nitrides, fluorides, and sulfides of the group consisting of silicon carbides, boron carbide, titanium carbide, silicon dioxide, manganese oxide, titanium oxide, zirconium oxide, aluminum oxide, ferric oxide, chromic oxide, boron nitride, calcium fluoride, stronium fluoride, barium fluoride, zinc sulfide, cadmium sulfide, and iron silicide. Of the foregoing, kaolin (china clay) is particularly satisfactory and finely powdered glass is also suitable when employed in size ranges below about 5 microns and preferably below about 2 microns to as low as about .1 micron and smaller.

In the self-contained system shown in FIGURE 1, the tank **10** is provided with suitable agitation means (not shown) for maintaining the insoluble particles in the

slurry substantially uniformly distributed therethrough. Withdrawal of the slurry from the tank is achieved by a perforated suction tube 12 mounted along the side wall of the tank 10 having a plurality of perforations 14 therein through which the slurry enters at spaced intervals throughout the entire depth of the tank. The upper end of the suction tube 12 is removably connected to an inlet pipe 16 connected to the suction side of a pump 18 which is drivingly connected to a motor 20 mounted on a supporting frame 22. The slurry is discharged from the discharge side of the pump 18 through an outlet pipe 24 which is removably connected to an inlet pipe 26 of a filter apparatus 28. The slurry passes through the filter apparatus 28 during which any large particles entrained in the slurry above a preselected size range are removed and the filtered slurry and extremely fine-sized particles therein are returned to the tank 10 through a drain or a discharge pipe 30 at the base of the filter apparatus 28. The operation of the filtration system can be accomplished continuously or on an intermittent basis depending on the rate of buildup of undesirable large particles and the concentration thereof which can be tolerated in the slurry.

The filter apparatus 28 as best shown in FIGS. 2 through 4, comprises a receptacle such as a cylindrical drum 32 including a base or bottom member 34. The drum 32 may be open at the top when gravity flow of the slurry is employed. The drum may be of any suitable material of satisfactory strength such as steel, for example, and if subjected to alkaline or acidic slurries, such as an acidic nickel plating slurry of the hereinbefore mentioned type then the interior surfaces of the drum 32 are preferably provided with a protective coating 36 such as a coating of polyvinyl chloride plastic, for example, to prevent corrosive attack thereof. Alternatively, the drum in such case can be constructed of a plastic material such as reinforced polyester or phenolic resin, for example, which is resistant to the alkaline and acidic solutions in contact therewith. In this connection, it will also be appreciated that the suction tube 12, the inlet and outlet pipes 16 and 24, and the inlet pipe 26 to the filter, should be of a suitable non-corrosive material such as rigid polyvinyl chloride plastic, for example, to resist corrosive attack of any heated alkaline and acidic solutions to which they may be exposed. The pump 18 similarly may be of suitable plastic or stainless steel alloy to resist corrosive attack of the acidic and alkaline slurries.

Removably positioned within the interior of the drum 32 is a pedestal 38 including a base 40 disposed in bearing contact against the bottom member 34 and a rod 42 affixed thereto and extending substantially perpendicular therefrom and positioned in substanital axial alignment with the longitudinal axis of the drum 32. The pedestal 38 is provided with the protective coating 36 over the surface thereof to prevent corrosive attack by any acidic or alkaline slurries to which it may be exposed. A series of tubular cylindrical spacer sleeves 44 are slidably disposed around the rod 42 of the pedestal 38 and are adapted to support a series of trays 46 in substantially horizontal and appropriately vertical spaced relationship. Each of the trays 46 are of a perforated construction and may comprise an expanded sheet of metal of the configuration as shown in FIG. 4. The surfaces of the trays 46 are similarly provided with a layer of the protective coating 36 thereover. The central portion of the trays 46 are preferably rigidified by incorporating an annular collar or washer 48 having a central aperture therethrough which slidably overlies the rod 42 of the pedestal 38.

The upper projecting end of the rod 42 is provided with a threaded portion which is adapted to be threadably engaged in a threaded bore 50 extending upwardly and axially along substantially the longitudinal axis of a combination nozzle and deflector member 52 which is disposed centrally of and adjacent to the upper surface of the top filtering tier of the filter apparatus 28. The upper end of the combination nozzle and deflector member 52 as viewed in FIG. 2 is provided with a threaded collar adapted to threadably engage a coupling 54 which in turn is threadably engaged to the inlet pipe 26 extending axially downwardly through the top of the drum 32. The upper threaded flange of the nozzle and deflector member 52, as is best shown in FIGS. 2 and 3, is provided with a plurality of axial nozzles 56 therethrough which are located in a circular arrangement and can vary in number and size depending on the specific capacity and rate of flow of slurry through the filter. The nozzles 56 are disposed in communication with the interior of the coupling 54 and inlet pipe 26 and serve to discharge the slurry entering the filter apparatus tangentially along the downwardly and outwardly flaring surface of the nozzle and deflector member 52 so as to direct the slurry in a radial direction as indicated by the arrows in FIG. 4 achieving maximum utilization of the surface of the upper tier of the filter.

The radial discharge of the slurry as a result of the deflecting tendency of the nozzle and deflector member 52 also serves to sweep the inner annular surface and wash any large solid particles entrapped thereon toward the peripheral edges of the filter forming a sludge build-up generally indicated at 58. This discharge pattern serves as a self-cleaning feature and increases the efficiency of the filter as well as increasing the duration between the cleansing of the filtering tiers to remove the sludge 58 therefrom. A number of suitable spacer washers 57 can be disposed between the upper filtering tier and the base of the nozzle and deflector member 52 so as to adjust the relative elevation between the deflecting surface thereof and the upper surface of the filter medium positioned on the upper tray 46 achieving the desired radial impingement of the slurry discharged through the nozzles 56.

In the specific filter shown in the drawings, three trays 46 are employed forming three filtering tiers each of which is provided with a different filter medium overlying the upper surface thereof. The top filtering tier as viewed in FIG. 2 comprises a coarse, relatively open weave material 59 which is formed in the shape of a shallow pan comprising a circular base 60 having an upstanding side wall 62 extending around the periphery of the base 60 and integrally affixed thereto. The side wall 62 prevents the sludge accumulation 58 along the outer portions of the first tier from overflowing and passing downwardly through the adjacent tiers.

The open weave material 59 is preferably constructed from a chemically resistant fiber which is inert to and unaffected by the acidic or alkaline slurries impinging thereon. A material which has been found surprisingly effective for filtering deleterious large sized particles having a size range of about 50 microns or greater in the acidic satin-like nickel plating slurries hereinbefore described and concurrently allowing the relatively high solids content of fine-sized insoluble particles to pass therethrough comprises an open weave Saran cloth designated as fabric 1057–000 of a 20 ounce per yard weight manufactured by the Chicopee Manufacturing Corporation. This fabric is characterized as being substantially inert to the acidic slurries impinging thereon and comprises a three dimensional matrix having a depth of about ⅛ inch composed of interwoven monofilament Saran fibers of about 12 mil filament diameter woven in a satin weave pattern providing nominal openings which prevent passage of spherical glass beads of about 250 microns in diameter. The surface structure of this Saran fabric enables the deflected impinging stream of the slurry to wash any large particles retained thereon toward the periphery of the material 59 resulting in an accumulation of sludge 58 as indicated in FIG. 2 providing continued high efficient filtration through the inner circular portion thereof. Satisfactory removal of objectionable large solids from the aforementioned satin-like nickel plating solution can satisfactorily be accomplished by employing a single filtering tier provided with the open weave Saran cloth or fabric designated 1057–000.

It is usually preferred, however, to employ two, three, or more filtering tiers each of which employs filtering medium thereon having a progressively smaller porosity to remove therefrom particles of a size between that which passes through the first filtering medium and the particles of a preselected size which are intended to be returned to the slurry tank. In the filter shown in FIG. 2, the middle tier is provided with a filter medium **64** of an open mesh construction having a porosity smaller than that of the upper tier filter medium **59**. Materials suitable for this purpose include a Saran woven cloth designated 1017–000 supplied by the Chicopee Manufacturing Corporation which is an 11½ ounce/yard fabric woven of Saran filaments of 8 mil diameter in a basket weave and which is effective to retain spherical glass beads of about 50 microns in diameter. This fabric is effective to retain irregularly shaped particles which pass the material **59** but still permit the desirable solids of a particle size of less than about 20 microns in the slurry to pass therethrough. An alternate satisfactory filter medium for the middle tier can comprise a chemically resistant glass wool or other wool comprised of a fiber which is resistant to attack by any alkaline or acidic slurries to which it may be exposed and which is formed in a three-dimensional mat having an irregular porosity. A typical example includes a mat comprised of Dynel fibers manufactured by the Union Carbide Corporation which retains relatively fine solid particles but enables the desirable insoluble particles of a size of about 15 microns or less to pass through unhampered. The bottom tier is provided with a filter medium **66** which is of still a finer porosity and may, for example, comprise two layers of a glass wool or Dynel wool of the type employed for the middle tier filter medium **64** which is effective to remove particles greater than about 10 microns.

The flow of the slurry through the tiered filter shown in FIG. 2 is achieved by gravity wherein the slurry discharged in a radial pattern on the upper tier drips through the filter medium **59** and tray **46** thereof and thence downwardly and successively through the middle tier and lower tiers and finally flows out of the base of drum **32** through the disharge pipe **30** and is returned to the tank **10**. The filter is used continuously or intermittently until the accumulation of the sludge **58** along the upper filter medium **59** reaches a magnitude wherein the sludge itself serves as a filter medium entrapping the extremely fine-sized particles in the slurry which impinges thereon. If this condition progresses to the extent that the filter becomes plugged, the slurry may accumulate until it reaches the level of an overflow pipe **68** in the upper portion of the drum **32** from which it is returned back to the tank **10**.

The filter is simply cleaned by disconnecting the inlet pipe **26** from the outlet pipe **24** and thereafter withdrawing the entire inner assembly of the filter from the drum **32**. The filter medium on each of the trays is then subjected to water immersion or a high pressure spray to back-wash and dislodge any large particles accumulated thereon. After the filter media have been cleaned, the filter is reassembled merely by reinserting the inner assembly in the drum and connecting the inlet pipe **26** to the outlet pipe **24**.

The filter apparatus hereinbefore described can also be satisfactorily employed by placing it in series, either before or after other conventional filter apparatus to preliminarily remove large size particles or as a safeguard in the event of failure of the principal filter. While it will be apparent that the preferred embodiments herein illustrated are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a filtration apparatus for removing insoluble particles in a slurry above a preselected size the combination comprising a receptacle, inlet means for supplying a flow of slurry having a finely particulated solids content ranging from about 10 grams to about 500 grams per liter of a particle size predominantly less than about 15 microns, filter means disposed transversely of said receptacle and positioned in a substantially horizontal plane, said filter means comprising a three-dimensional open weave cloth having a porosity so as to retain spherical solids of a size greater than about 250 microns and formed in the configuration of a pan comprising a horizontal base portion and an upstanding wall portion connected to and extending along the periphery of said base portion, combination nozzle and deflector means disposed adjacent to the upper surface of said filter means for discharging the slurry from said inlet means in an outwardly directed radial direction above substantially the center portion of said filter means, said deflector means including a body defining an arcuate downwardly and outwardly flared surface of a circular cross section, said nozzle means including substantially vertically oriented discharge means disposed adjacent to the upper end of said deflector means for discharging the slurry downwardly along said flared surface and in a radial and outward direction from the circular peripheral edge thereof in the form of a substantially continuous curtain across the upper surface of said filter means, and drain means at the lower portion of said receptacle for discharging the filtered slurry from said filtration apparatus.

2. In a filtration apparatus for removing insoluble particles above a preselected size from a slurry, the combination comprising a receptacle, inlet means for supplying a flow of slurry having a finely particulated solids content ranging from about 10 grams to about 500 grams per liter of a particle size predominantly less than about 15 microns, filter means comprising a plurality of tiers of filter medium disposed in vertically spaced relationship one above the other and in substantially horizontal planes, said filter medium of said tiers having a progressively decreasing porosity progressing from the uppermost of said tiers to the lowermost of said tiers and operative to retain solids thereon of a size greater than about 15 microns entrained in the slurry and to pass the liquid and remaining solids content therein through said filter medium by gravity flow, each of said tiers comprising a perforated support member and an overlying filter medium supported thereon, a pedestal supported on the base of said receptacle and extending upwardly therefrom through substantially the midpoint of each of said tiers, spacer means associated with said pedestal and cooperating with adjacent ones of said tiers for maintaining said tiers in appropriately vertically spaced relationship, combination nozzle and deflector means removably mounted on the upper end of said pedestal adjacent to the uppermost of said tiers for clamping said tiers between said spacer means and for discharging the slurry from said inlet means in an outwardly directed radial direction above substantially the center portion of said filter medium on said uppermost of said tiers, drainage means in the lower portion of said receptacle for discharging the filtered slurry from said receptacle, and overflow means in the upper portion of said receptacle above said uppermost of said tiers.

3. In a nickel plating apparatus for electrodepositing a satin-like nickel finish on the surface of a base metal, the combination comprising a tank, a liquid slurry in said tank including a soluble nickel salt and an extremely fine-sized insoluble particulated solids content suspended therein ranging in concentration from about 10 grams to about 500 grams per liter and having a particle size predominantly less than about 5 microns, pumping means including inlet means immersed in said slurry for withdrawing a quantity thereof, a filter apparatus disposed adjacent to said tank, conduit means connected to said pumping means for supplying a flow of slurry to said filter appa-

ratus, said filter apparatus comprising a receptacle, filter means disposed transversely of said receptacle and positioned in a substantially horizontal plane, combination nozzle and deflector means for discharging said slurry from said conduit means in an outwardly directed radial direction adjacent to the upper surface of an above substantially the center portion of said filter means, said deflector means including a body defining an arcuate downwardly and outwardly flared surface of a circular cross section, said nozzle means including substantially vertically oriented discharge means disposed adjacent to the upper end of said deflector means for discharging the slurry downwardly along said flared surface and in a radial and outward direction from the circular peripheral edge thereof in the form of a substantially continuous curtain across the upper surface of said filter means, said filter means having a porosity to retain solids thereon of a size greater than about 10 microns entrained in said slurry and to pass the liquid and remaining solids content

of said slurry by gravity flow through said filter means, and drain means at the lower portion of said receptacle for discharging the filtered said slurry from said filter apparatus to said tank.

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