Oct. 11, 1938. J. D. MOONEY 2,132,514

APPARATUS DESIGNED TO ILLUSTRATE THE LAWS OF ECONOMICS BY PHYSICAL ANALOGIES

Filed Oct. 6, 1937 5 Sheets-Sheet 1

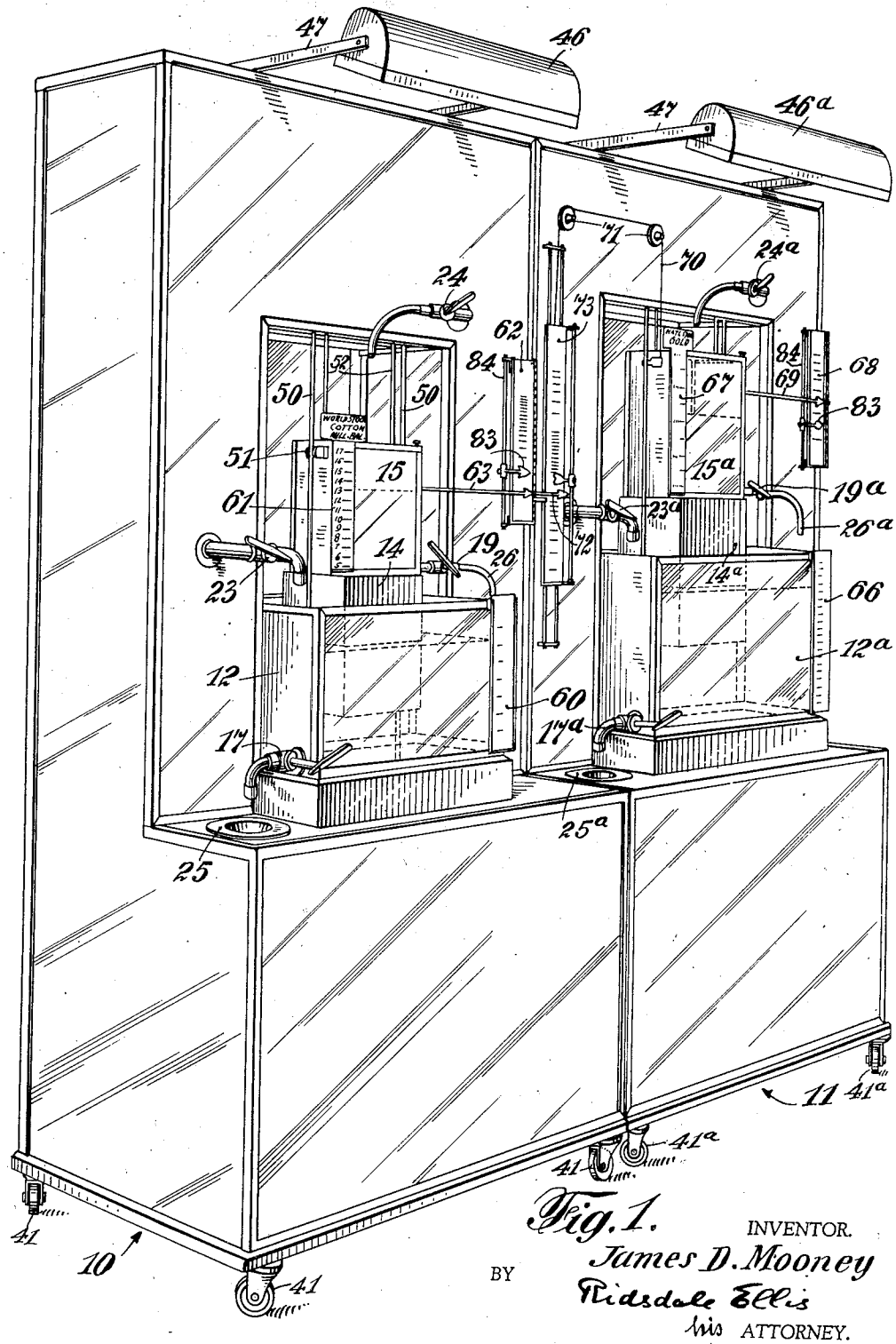


Fig. 1.

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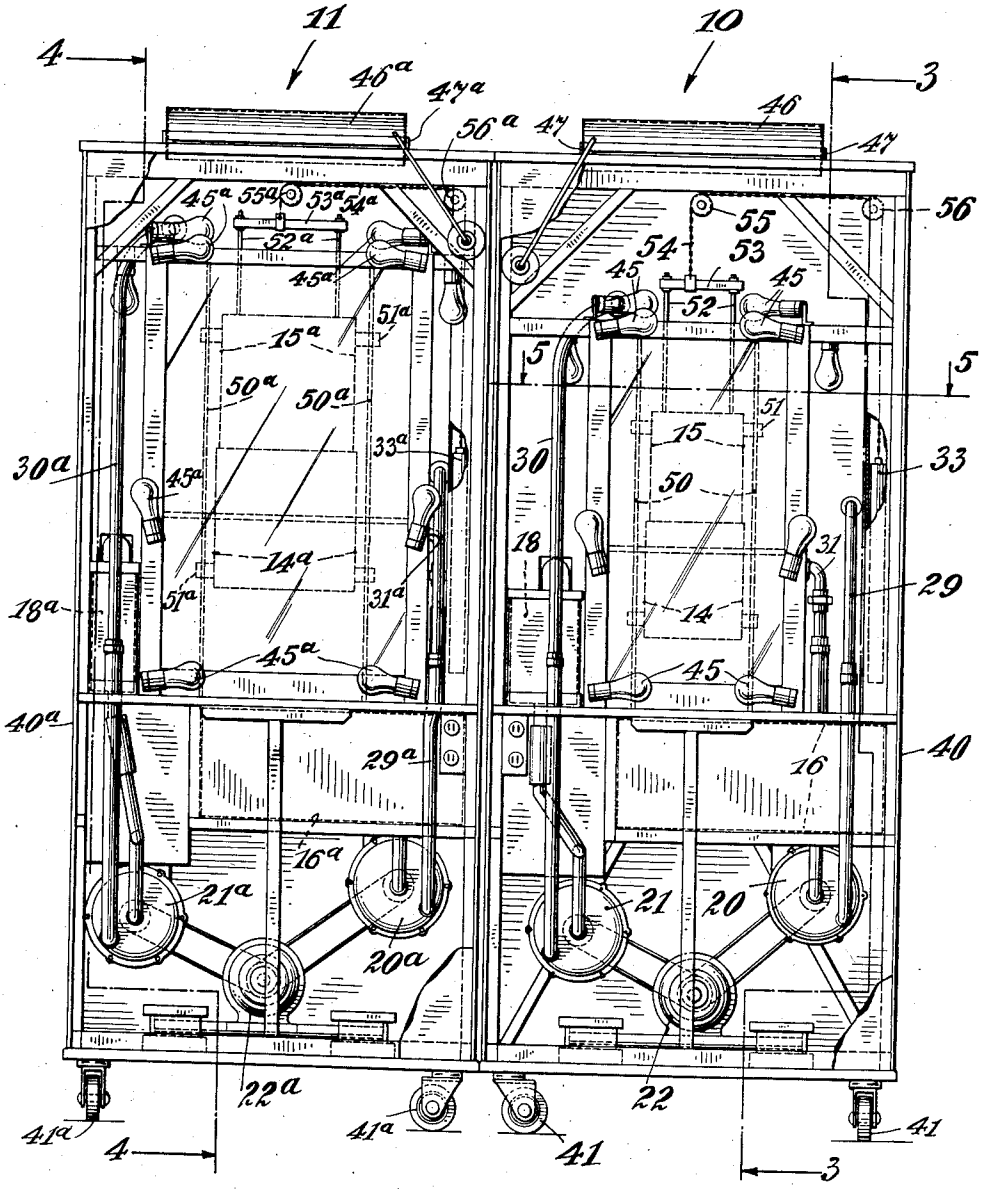


Fig. 2.

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APPARATUS DESIGNED TO ILLUSTRATE THE LAWS OF ECONOMICS BY PHYSICAL ANALOGIES

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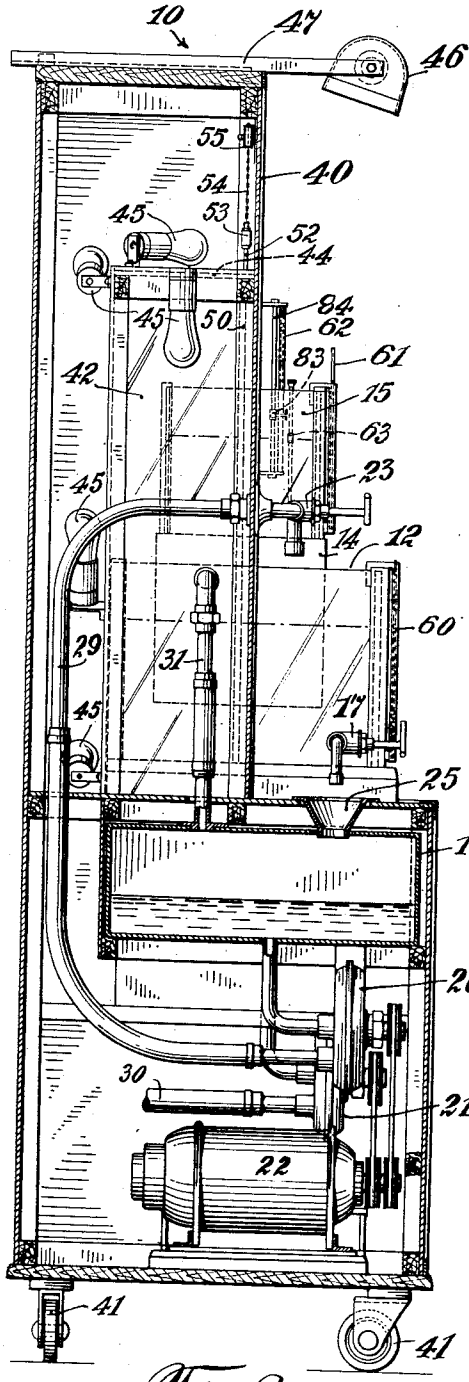


Fig. 3.

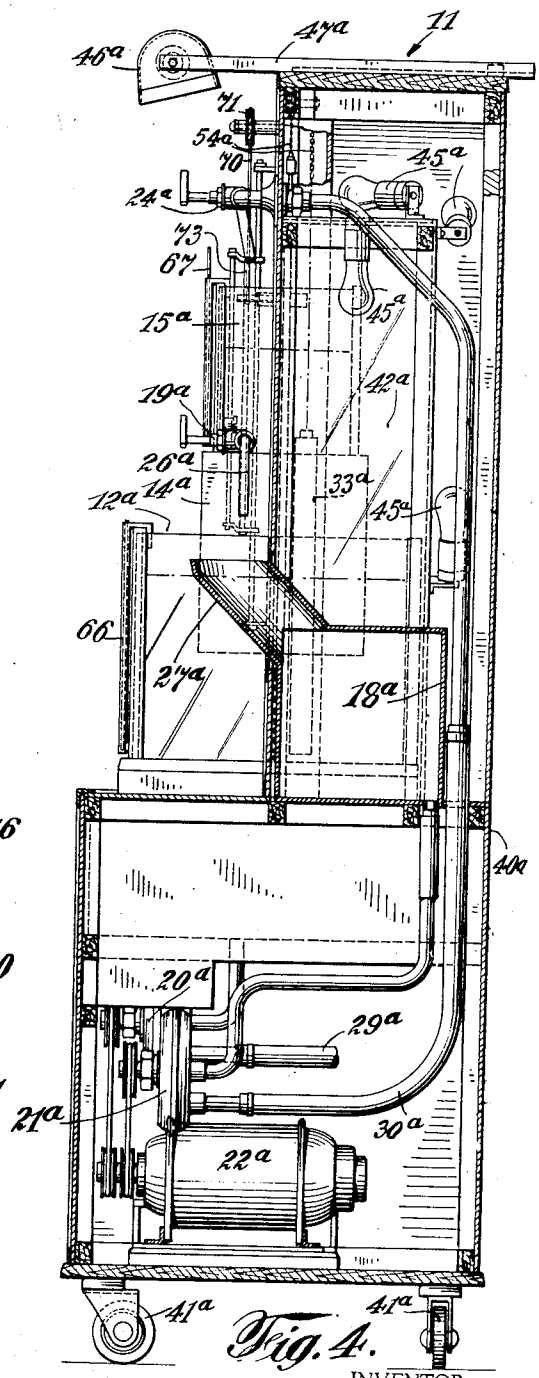


Fig. 4.

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APPARATUS DESIGNED TO ILLUSTRATE THE LAWS OF ECONOMICS BY PHYSICAL ANALOGIES

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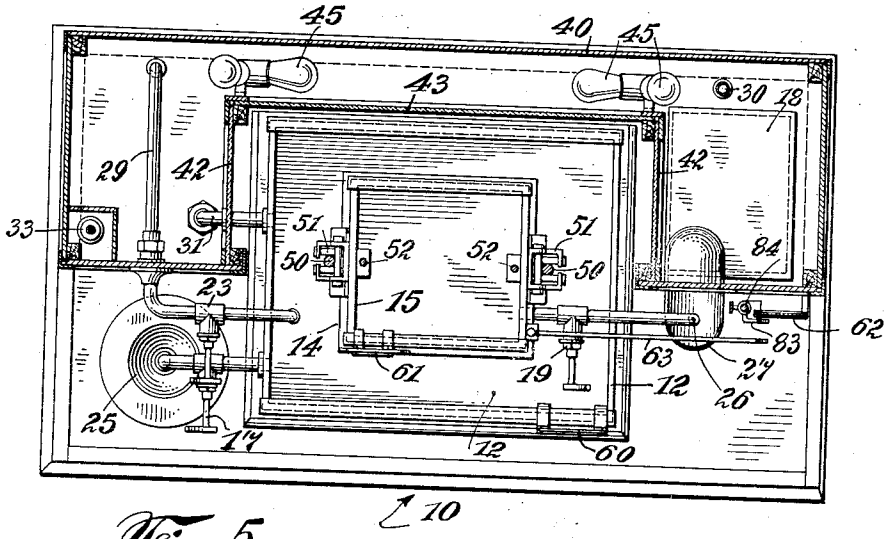


Fig. 5.

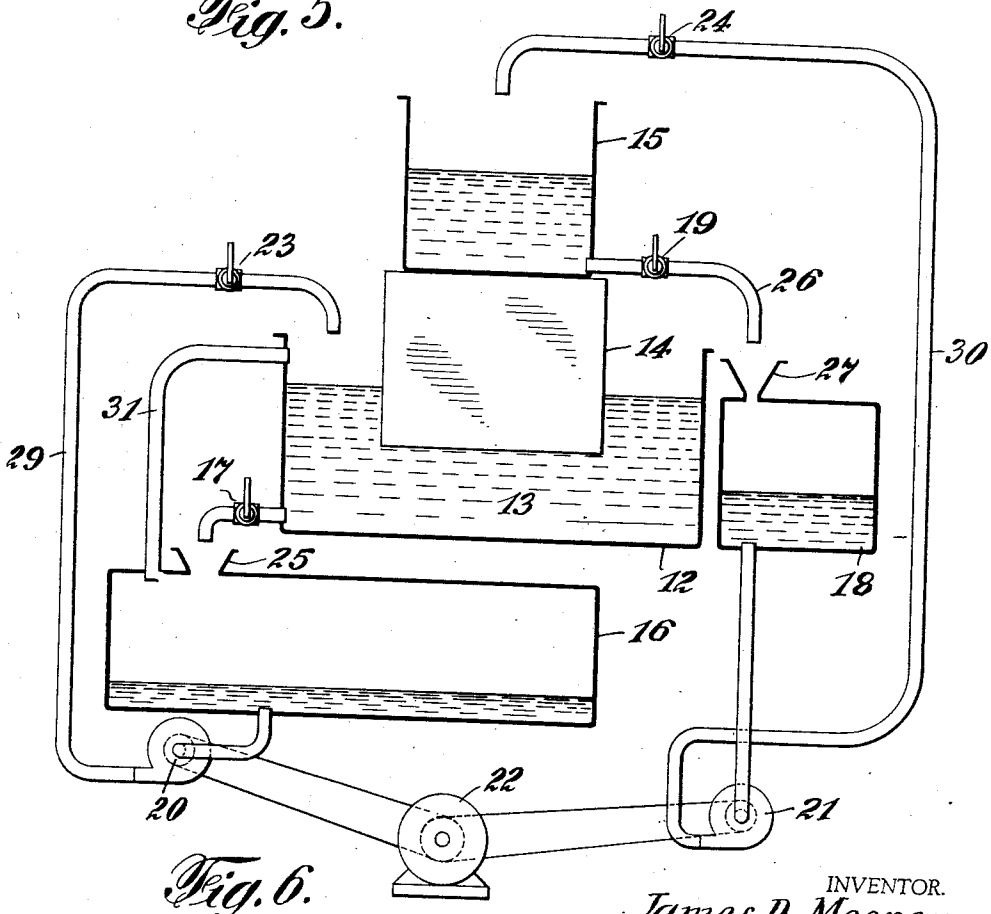


Fig. 6.

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APPARATUS DESIGNED TO ILLUSTRATE THE LAWS OF ECONOMICS BY PHYSICAL ANALOGIES

Filed Oct. 6, 1937 5 Sheets-Sheet 5

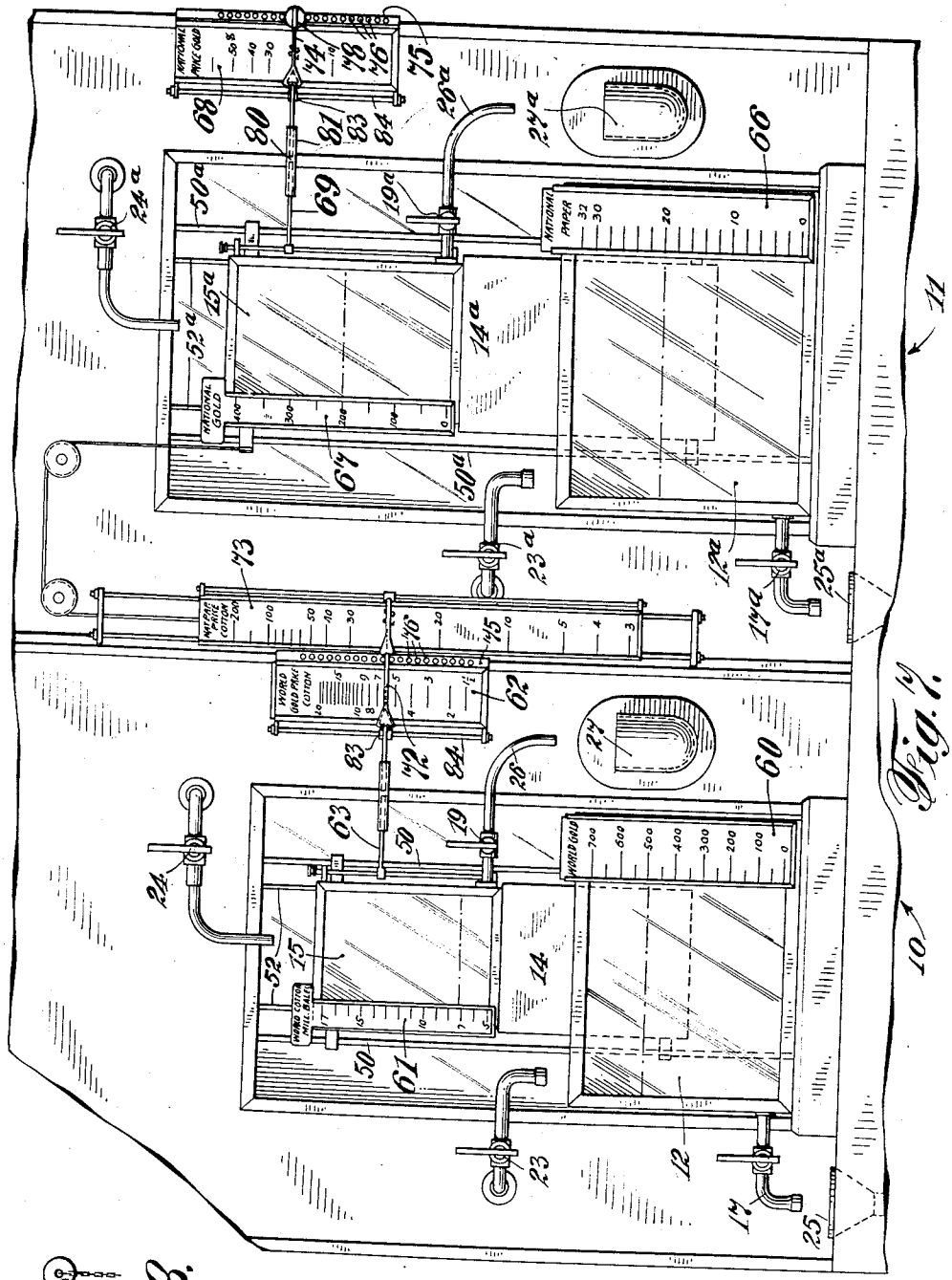


Fig. 1.



Fig. 8.

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Patented Oct. 11, 1938

2,132,514

UNITED STATES PATENT OFFICE

2,132,514

APPARATUS DESIGNED TO ILLUSTRATE THE LAWS OF ECONOMICS BY PHYSICAL ANALOGIES

James D. Mooney, Oyster Bay, N. Y.

Application October 6, 1937, Serial No. 167,559

13 Claims. (Cl. 35—24)

This invention relates to apparatus designed to illustrate the laws of economics by physical analogies, such as set forth in my U. S. Patent No. 1,989,878.

The principal object of the present invention is to provide improved means whereby such laws may be illustrated and taught concretely so that the mind obtains a physical picture to aid what have hitherto been largely, if not entirely, abstract conceptions.

In general, it can be said that one economic factor at a time may be translated into the physical analogy in such manner as will maintain the integrity of the direction of its force, according to the law of supply and demand. Thus, one can take economic laws, translate them into algebraic expressions, and then express the algebra in a physical analogy. When the physical analogy is complete, the general relationships of the various forces can be observed, expressed and finally interpreted back from the physical analogy into economic terms and patterns.

The price of a commodity may, and in fact always does, depend on a variety of factors all governed by the law of supply and demand. For example, the price of cotton is dependent upon, not only the supply and demand for cotton, but also on the supply and demand for the medium of exchange by which it is purchased, and numerous other factors.

Mechanically, this is demonstrated by using a tank and a float therein supported a receptacle, both tank and receptacle being provided with means for introducing liquid, to represent supply, and with means for discharging liquid, to represent demand, and by providing means for indicating the change in the absolute height of the float and liquid receptacle. The absolute height of the float is an indication of the algebraical sum of the effect of the operation of the law of supply and demand on both commodity and medium of exchange, etc.

The present invention also includes means for operating two or more tank and float units in unison so as to demonstrate the integration of a much larger number of economic factors than is possible by a single unit.

The prior apparatus has also been improved mechanically so as to give maximum movement of the parts for a given size of apparatus and improved in various other ways so as to make its operation more readily demonstrable, as regards the demonstrator, and also more readily observable, as regards the audience.

Another important feature of this invention is the provision of means for demonstrating physically the fact that one cannot interfere to any great extent with the operation of the law of supply and demand by such expedients as price fixing, etc.

Further features and advantages will be hereinafter described in connection with the description of a suitable form of apparatus shown, by way of example, in the accompanying drawings, in which:

Fig. 1 is a perspective view of a two-unit apparatus embodying the principles of the present invention;

Fig. 2 is a rear elevation of the same;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 is a section on the line 4—4 of Fig. 2;

Fig. 5 is a section on the line 5—5 of Fig. 2;

Fig. 6 is a diagrammatic view showing the relationship between various tanks, liquid receptacles and reservoirs and means for transferring the liquids to operate the apparatus;

Fig. 7 is a front elevation of the central section of the apparatus showing a specific set of scales representing the relationship of the price of cotton in terms of both gold and paper; and

Fig. 8 is a side elevation of a peg used to prevent normal operation of the float.

As illustrated, the apparatus comprises two demonstration units 10 and 11 constructed for separate and also conjoint use. As the general construction is the same in both units 10 and 11, one unit only will be described, viz: 10, so far as features common to both are concerned. The corresponding parts in unit 11 are given the same reference numerals with the suffix *a*.

The main hydraulic and mechanical features are shown diagrammatically in Fig. 6. A tank 12 contains liquid 13 which supports (with the aid of a counter weight not shown in this figure) a float 14 carrying a liquid receptacle 15. The tank 12 and receptacle 15 are formed of glass plates united by metal corner pieces, like the ordinary house aquarium. The float 14 is a rectangular metal box.

Liquid may be drained off from tank 12 into a funnel 25 leading into a reservoir 16 by opening valve 17, and liquid may be drawn off from receptacle 15 by opening valve 19 in a pipe 26, discharging into a funnel 27 leading to a reservoir 18. For returning liquid into tank 12 and receptacle 15, pumps 20 and 21, respectively, are provided, the discharge pipes 29 and 30 from which are controlled by valves 23 and 24 respectively.

To advantage the tank 12 is provided with an overflow pipe 31. The pumps 20 and 21 are of centrifugal or other type capable of creating a limited pressure beyond which there is no discharge. Such a type of pump may be continuously driven by a motor, such as 22, and will deliver liquid as soon as the valve on its discharge pipe is opened.

As there is in commerce a continuous though variable supply of a commodity and a continuous though variable demand therefor, actual economic

conditions may be represented by operating the apparatus with all valves more or less open and demonstrating the effect of changes in one or more of the economic factors by varying the extent to which one or more of the valves open. The rate of flow through the "demand" valves 17 and 19 is proportional to the head of liquid in the tank 12 and the receptacle 15, respectively. If, therefore, one of the "supply" valves, say 23, is opened wider to increase the rate at which liquid enters tank 12, the liquid level in the latter rises until the hydrostatic head is high enough to cause liquid to flow out through the "demand" valve 17 at the same rate as it enters the tank 12 through "supply" valve 23. Equilibrium is then established and no further change or level occurs until the setting of one or other of the valves 23 and 17 is charged.

One of the advantages of the present apparatus is that, unlike practical commercial conditions, one factor (say supply) may be fixed, while another (say demand) is varied, so that the effect of such variation becomes much more apparent than when both factors are changing continuously and simultaneously.

If the weight of the liquid in the receptacle 15 were supported solely by the buoyancy of the float 14, then the latter would displace an amount of liquid equal to the sum of the weight of liquid in the receptacle and the weight of the receptacle and float. It follows that, if, of the total depth to which the float is submerged, only ⅓ is due to the weight of liquid in the receptacle, either the distance the float rises and falls as the liquid in the receptacle decreases and increases is small, so that the efficiency of the apparatus for demonstration purposes is reduced, or the tank and float must be made excessively deep. To avoid this dilemma the float and receptacle are counterweighted, preferably to the extent that nearly all of the combined weight of the float and receptacle (empty) is carried by the counterweight. The counterweight 33 is shown most clearly in Fig. 2.

The hydraulic and mechanical elements above described are housed in a cabinet 40 mounted on castor wheels 41. The lower part of the cabinet houses the reservoir 16, pumps 20 and 21 and the motor 22. The upper part of the cabinet is set back and is provided with a deep central recess, as shown in Fig. 5, the side, back and top walls 42, 43 and 44 of which are formed of translucent material, such as frosted glass. These walls are illuminated from the rear by a number of electric lights 45.

The tank 12 rests on the top of the lower part of the cabinet and is so arranged that its rear half is in the recess in the upper part of the cabinet and its front half is outside of and in front of such recess. The back lighting from the walls of the recess makes the tank 12, float 14 and receptacle 15 clearly visible, including the liquid levels in the tank 12 and receptacle 15. To give additional illumination, if desired, a hooded light 46 may be mounted on brackets 47 extending forwardly from the top of the cabinet.

On each side of the float and receptacle is a vertical guide rod 50, and the float and receptacle are provided with pairs of slides 51, preferably of an anti-friction type such as a plurality of rollers, engaging such rods.

Extending upwardly from the receptacle 15 through the top of the recess are a pair of rods 52 connected at their upper ends by a cross-bar 53 to which is attached a chain or cord 54 leading over pulleys 55 and 56 to the counterweight 33.

All of the elements so far described are common to the two units. The next set of elements to be described are the scales, pointers co-operating therewith and other correlated elements. These will be described individually for both units in order that the conjoint use of the two units may be explained.

Along one side of tank 12 is a scale 60 for measuring the height of liquid therein with graduations representing the world's stock of monetary gold. By opening the valve 17 and permitting some of the liquid in 12 to run out and thereby lower the liquid level, the apparatus indicates a lowering of the world's stock of monetary gold.

Along one side of the receptacle 15 is a scale 61 for measuring the height of liquid therein with graduations representing the world's stock of cotton. By varying the degree of opening of one or the other or both the valves 24 and 19, the liquid level in the receptacle may be changed to indicate a change in the world's stock of cotton.

On the right margin of the cabinet of unit 10 is a third scale 62 over which extends a pointer arm 63. This scale 62 has graduations thereon representing the world gold value of cotton. It will be noted that the position of this arm is dependent on two factors, one the height of the liquid in tank 12 and the other the height of the liquid in receptacle 15. These liquid heights vary whenever the rates at which liquid enters and leaves either the tank 12 or receptacle 15 are varied.

The apparatus, therefore, portrays the law of supply and demand clearly and accurately, for example:

If the stock of gold (represented by the liquid level in tank 12) is substantially stationary, then the gold value of cotton varies with changes in the supply and demand for cotton (represented by the liquid level in receptacle 15). At any time when the world stock of cotton increases the world value of cotton in terms of gold will decrease, as indicated on scale 62. Conversely, when the stock of cotton is depleted by an excess of demand over supply the world value of cotton will increase. If, however, the stock of cotton is substantially stationary and the stock of gold varies then the gold value of cotton will change accordingly. That is, if the world stock of monetary gold should increase, due to excess of supply over demand, the value of cotton, in terms of that gold will increase, as shown on the scale 62.

If the stock of gold increases while the stock of cotton decreases, the two effects tend to neutralize each other and the final resultant change in the gold value of cotton may be zero.

Expressed algebraically:

World gold value of cotton (expressed in grains of gold)

$$=GV=\frac{DC}{SC}\times\frac{SG}{DG}$$

Where

DC=World demand for cotton
SC=World supply of cotton
SG=World supply of gold
DG=World demand for gold

The unit 11 has a scale 66 along one side of the tank 12*a* representing the stock of paper currency in U. S. A. On the receptacle 15*a* is a scale 67 representing the stock of gold in the U. S. A. Along the right margin of the unit 11 is a scale 68 with graduations thereon representing the

price of gold in U. S. A. in terms of paper currency of that country. Over this scale **68** extends a pointer arm **69**, to indicate the absolute height of the float and receptacle, the vertical position of which is dependent upon two factors, one the height of the liquid in tank **12***a* and the other the height of the liquid in receptacle **15***a*. Pointers **83** slidable on rods **84** alongside certain of the scales may be used to mark the initial positions of the pointer arms **63**, etc.

The paper money price of a commodity is the same as the gold price whenever the probabilities are 100 in 100 that the paper is redeemable at its face value (or parity) in gold. When, however, the stock of paper money increases unduly and the public begins to feel that the probabilities of redemption at par are only say 90 in 100, two things happen. First, the price of gold dollars in terms of paper dollars goes up, so that $111 in paper are required to buy $100 in gold. Second, gold is exported or hoarded, thereby reducing the stock of gold in U. S. A. This reduction in the stock of gold in turn decreases public confidence in the paper money, so that $120 in paper are required to buy $100 in gold, and the vicious cycle is repeated. This double effect on the price of gold in terms of paper can be demonstrated by opening valve **23***a* and **19***a* wider to represent an increase in the supply of paper money and an increased demand for gold (for export or for hoarding) respectively. The result is to raise the level of liquid in the tank **12***a* and thereby raise the float a like amount and also to lower the level of liquid in the receptacle **15***a*, thereby reducing the downward pressure on the float which causes the latter to rise with respect to the level of liquid in tank **12***a*. In other words, the float has two rising movements, one due to the increase in stock of paper and the other due to the decrease in stock of gold. The sum of these two movements is indicated by the pointer arm **69** on the scale **68**.

Expressed algebraically:

Paper price of gold in U. S. A. (expressed in dollars)

$$=PG=\frac{Dg}{Sg}\times\frac{Sp}{Dp}$$

Where:

Dg=U. S. demand for gold
Sg=U. S. supply of gold
Sp=U. S. supply of paper
Dp=U. S. demand for paper

To demonstrate the dependence of the paper price of cotton in U. S. A. expressed in dollars on world stocks of both gold and cotton, it is necessary to combine both of the above algebraic expressions as follows:

Paper price of cotton in U. S. A. (expressed in dollars)

$$=P=GV\times PG=\frac{DC}{SC}\times\frac{SG}{DG}\times\frac{Dg}{Sg}\times\frac{Sp}{Dp}$$

To demonstrate this complex relationship hydraulically by means of the present invention the two units **10** and **11** are placed side by side. The unit **11** is provided with a vertically slidable scale **73** along its left margin. This scale is connected to the receptacle **15***a* by a cord or chain **70** passing over pulleys **71**, so that, as the receptacle moves up, the scale moves down, and vice versa. This scale **73** is graduated to represent the paper price of cotton in U. S. A. The pointer arm **63** is provided with a detachable extension **72**, lying over the scale **73**, and the readings on the scale **73** indicated by such pointer arm extension gives the resultant of the above mentioned eight factors.

Each scale comprises two parts, one a metal plate with inwardly turned side and bottom edges, and the other a cardboard slip with the requisite graduations thereon held in place by such inturned edges. These slips may be graduated prior to the demonstration, or may be marked as required, during the progress of the demonstration. The use of such slips enables the apparatus to be used for illustrating the law of supply and demand for any desired commodity, wheat, shoes, labor, etc.

Fig. 7 illustrates how by suitable scale graduations the apparatus may demonstrate actual conditions at any definite time.

For example in 1925 the world stock of monetary gold was about 500 million fine ounces, the world stock of cotton was around 7.3 million bales, the U. S. stock of paper currency was about 20 million dollars and the U. S. stock of gold about 200 million ounces. With the liquid levels shown in Fig. 7 these factors are demonstrated on scales **60**, **61**, **66** and **67** respectively.

At the period in question the U. S. price of gold was $20.67 per fine ounce, as indicated on scale **68**. Scale **73** shows that at that time the U. S. price of cotton was 25 cents per lb. and scale **62** that the world gold price of cotton was 6 grains of gold per lb.

One of the economic principles which the present apparatus is designed to illustrate is that the law of supply and demand describes an ever changing group of economic forces. Prices and values are constantly changing and resist any attempt to fix them at any definite point. For example, the price of gold in terms of paper currency cannot be "pegged" and then the supply of paper currency increased indefinitely. Sooner or later the paper currency will depreciate to a value below that at which it has been artificially fixed.

To demonstrate that fact means are provided for preventing the float **14***a* rising as the water level in its tank rises or the water level in the receptacle carried by such float falls until the upward force exerted on the float is sufficient to break a replaceable part, trip a catch or the like, whereupon the float immediately rises to assume its normal position according to the law of supply and demand. The reverse effect would follow should the level in the tank fall or the level in the receptacle rise.

The particular means used in the present apparatus involve the use of a frangible pointer arm and means for holding the end of the pointer, and thereby the float, so that it cannot move vertically until the force exerted on the float is strong enough to break the pointer arm.

For holding the pointer arm **69** in place vertically, this arm is provided with a tip **74** extending laterally across a bar **75** arranged vertically along the right-hand edge of the scale **68**. In this bar are a series of holes **76** spaced so that any adjacent pair is adapted to receive the two prongs **77** of a peg **78**, (Fig. 8). By inserting the prongs in two of the holes **76** with the tip **74** of the pointer between them, the latter is prevented from moving vertically with the float **14***a* and receptacle **15***a*.

The necessary quality of frangibility under a predetermined pressure is imparted to the pointer arm **69** by making it in two sections abutting each other at the point **80**. The two sections are

held in alignment by a glass tube 81 slipped over the two ends like a sleeve, until the bending moment on the arm is sufficient to snap the glass tube. The section of the arm connected to the receptacle 15a is then free to move independently of the other section.

The pointer 63 is similarly constructed. With such construction the unit 10, with suitable scales could be used, like the unit 11, to demonstrate the effect of attempts to fix prices in any specific commodity.

What is claimed is:

1. Apparatus for illustrating economic laws, comprising a tank containing liquid, means for admitting liquid to and means for discharging liquid from said tank at relatively variable rates to represent the strength of two economic factors, a float in said tank, a liquid receptacle carried by the float, means for admitting liquid to and means for discharging liquid from said receptacle at relatively variable rates to represent the strength of two other economic factors, and means for indicating the algebraic sum of the vertical movements of said float and receptacle due to the variations in the heights of liquid in the tank and receptacle and thereby integrate the resultant effects of all four economic factors.

2. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float therein, a liquid receptacle carried by the float, means for admitting liquid to and means for discharging liquid from said receptacle at relatively variable rates to represent the relative strength of two economic factors, and a counter-weight connected to said float and receptacle to reduce the depth of submergence of the float due to the dead weight of the float and receptacle.

3. Apparatus for illustrating economic laws, comprising a float, hydraulic means for varying the vertical position of said float, means for locking said float in a fixed position vertically, said last mentioned means having a part adapted to yield suddenly when the upward or downward hydraulic pressure on the float becomes excessive.

4. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float therein, a second tank carried by the float, means for changing the liquid level in one of said tanks to change the absolute vertical position of the float to represent the change in price of a commodity according to the law of supply and demand, guides for the float and tank carried thereby, an arm extending laterally from one of the last mentioned parts, means for locking the end of said arm in a fixed position vertically, said arm having a section adapted to yield suddenly when the upward or downward pressure of the float and receptacle on such arm becomes excessive.

5. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float therein, a liquid receptacle carried by the float, means for admitting liquid to and means for discharging liquid from said receptacle at relatively variable rates to represent the relative strength of two economic factors, vertical guides for the float and receptacle, an arm extending laterally from one of the last mentioned parts, means for locking the end of said arm in a fixed position vertically, said arm having a section adapted to yield suddenly when the upward or downward pressure of the float and receptacle on such arm becomes excessive.

6. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float therein, a second tank carried by said float, means for admitting liquid to and means for discharging liquid from one of said tanks simultaneously, a cabinet having a recess in its front wall in which said tank and float are mounted, a portion of the wall of the recess being formed of translucent material, and a lamp in the cabinet behind said translucent material to illuminate the tank and float from the rear.

7. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float therein, a second tank carried by the float, a reservoir containing liquid, pump mechanism for raising liquid from the reservoir and delivering it to one of said tanks, a cabinet enclosing said reservoir and pump mechanism, said cabinet having a recess in its front wall in which the rear parts of said tank and float are mounted with the front parts of the tank and float projecting forwards beyond the front wall of the cabinet, a valve on the outside of said cabinet adapted to deliver liquid from said pump into said forwardly projecting part of said tank and to control the rate of such delivery to said tank, a discharge pipe leading from said forwardly projecting part of said last mentioned tank, and a funnel device extending through the front wall of said cabinet for receiving the discharge from said pipe and leading it by gravity into said reservoir.

8. Apparatus as in claim 6 in which the upper part of the cabinet is set back, the recess is formed in such upper part and the first tank rests in part on the top of the lower part of the cabinet and in part on the bottom of the recess.

9. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float therein, a second tank carried by the float, a reservoir containing liquid, pump mechanism for raising liquid from the reservoir and delivering it to one of said tanks, a cabinet enclosing said reservoir and pump mechanism, said cabinet having a recess in its front wall in which said tank and float are mounted, a portion of the wall of the recess being formed of translucent material, a lamp in the cabinet behind said translucent material to illuminate the tank and float from the rear, a valve on the outside of said cabinet for controlling the rate of such delivery to said tank, a discharge pipe leading from said last mentioned tank, and a funnel device extending through the front wall of said cabinet for receiving the discharge from said pipe and leading it by gravity into said reservoir.

10. Apparatus for illustrating economic laws comprising two float and tank units for demonstrating the law of supply and demand arranged side by side, a sliding scale on one of said units, a connection between the float of such unit and said sliding scale adapted to move the scale upwards when the float moves downwards and vice versa, and a pointer arm attached to the float of the other unit extending over said sliding scale.

11. A device for illustrating economic laws, comprising a tank containing liquid, a float therein, a second tank carried by said float, means for admitting liquid at a regulatable rate to and means for discharging liquid at a regulatable rate from one of said tanks to represent commodity supply and demand and scale means for measuring the level of liquid in the tank to give a numerical measure of the variations in stock of such commodity with relative changes in the supply and demand therefor.

12. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float there-

in, a liquid receptacle carried by the float, means for admitting liquid to and means for discharging liquid from said receptacle at relatively variable rates to represent the relative strength of two economic factors, a counterweight connected to each side of said float and receptacle to reduce the depth of submergence of the float due to the dead weight of the float and receptacle, the points of connection and the center of gravity of the float and receptacle all lying in substantially the same vertical plane, and a cabinet having a recess in its front wall in which the rear portions of said tank and float are mounted with the center of gravity of the float behind the plane of said front wall to enable the counterweights and the pulleys therefor to be mounted inside the cabinet.

13. Apparatus for illustrating economic laws, comprising a tank containing liquid, a float therein, a second tank carried by said float, means for admitting liquid to and means for discharging liquid from one of said tanks simultaneously, a cabinet having a recess in its front wall in which the rear portions of said tank and float are mounted, the front portions thereof projecting forwards beyond the front wall of the cabinet, and means for illuminating the tank and float from the rear.

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