Dec. 19, 1939. L. DAY 2,183,606

HIGH SPEED DIFFERENTIALLY FUNCTIONING ARTICLE SORTING

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FIG. 1

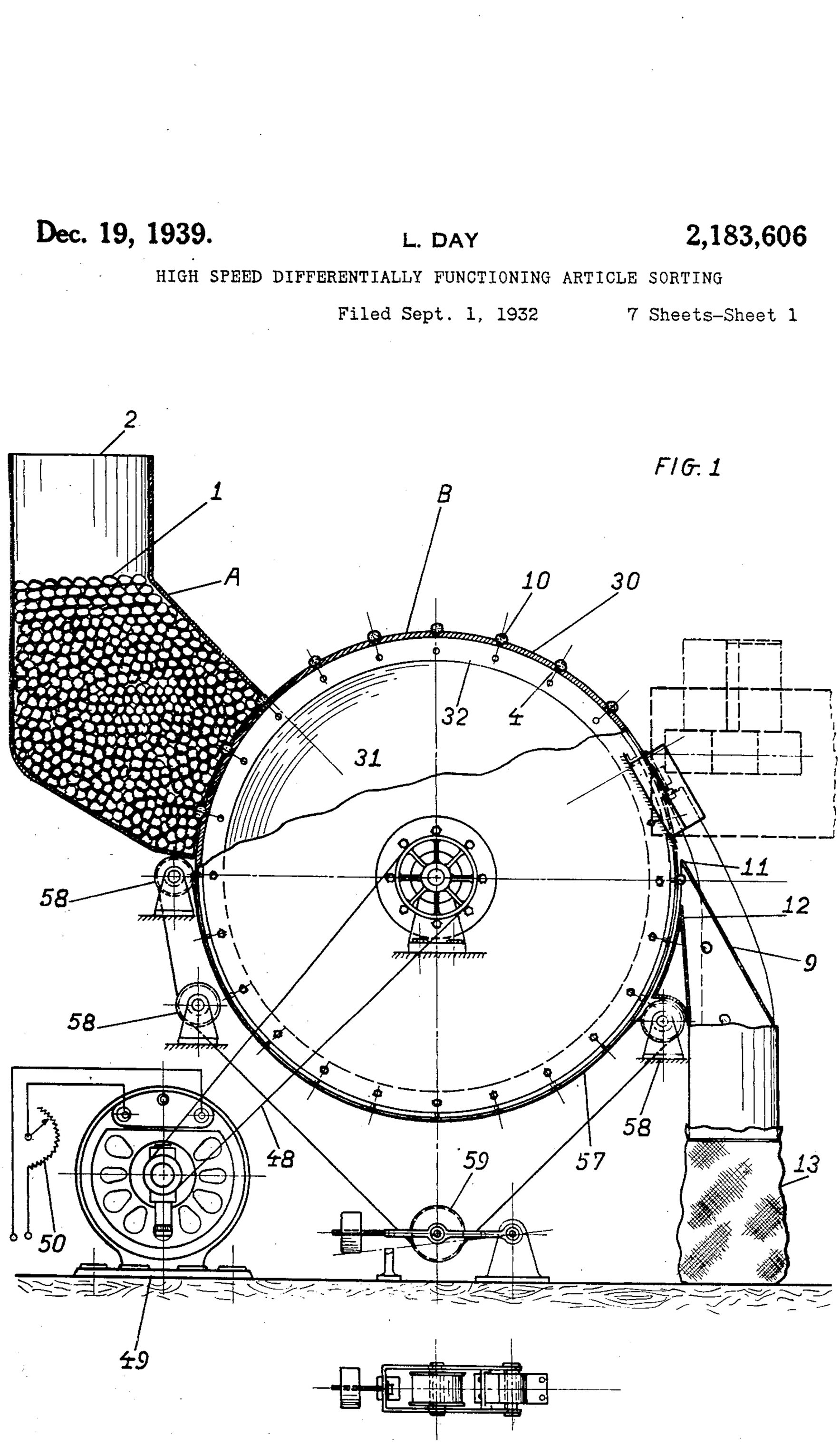

FIG. 1A

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HIGH SPEED DIFFERENTIALLY FUNCTIONING ARTICLE SORTING

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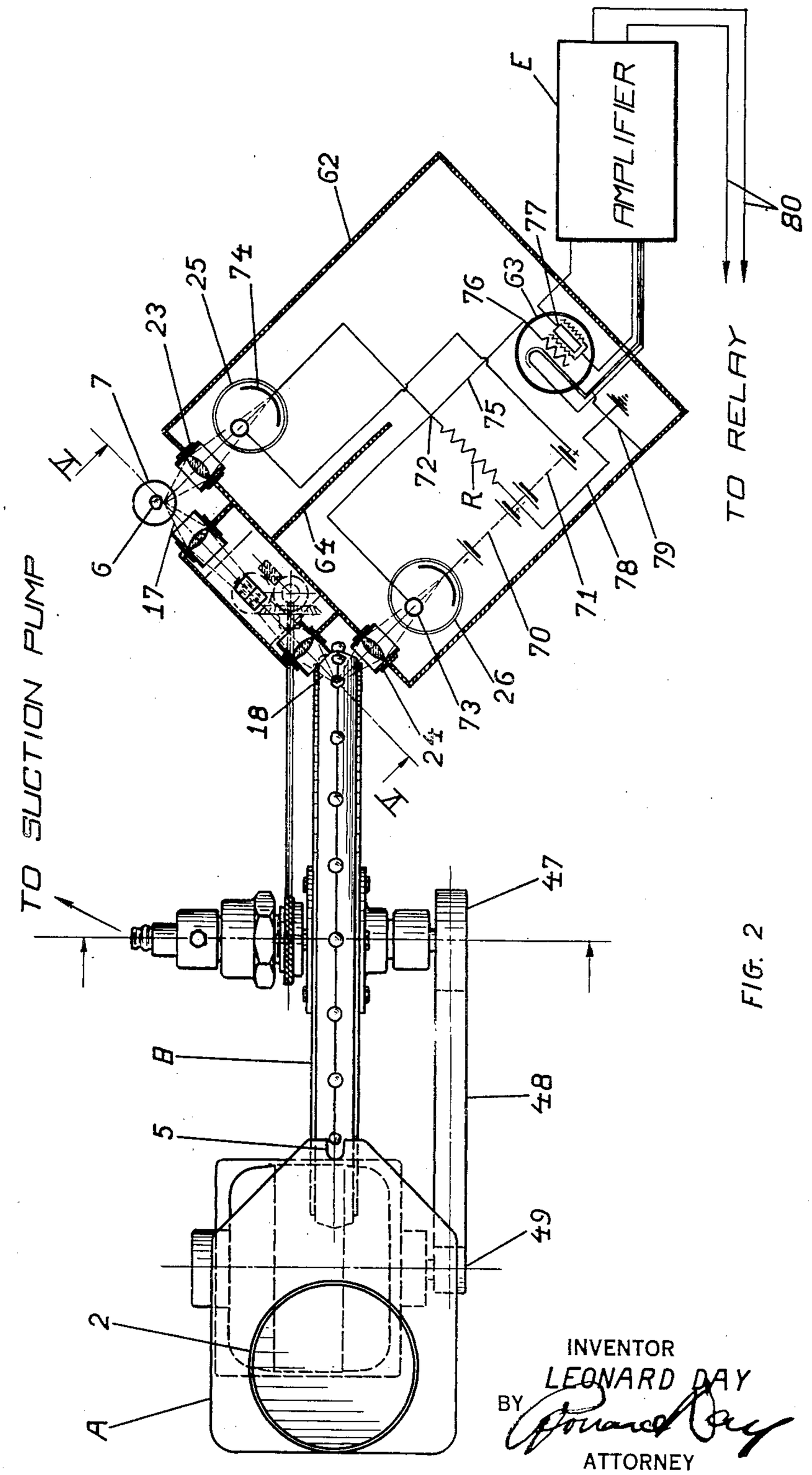

FIG. 2

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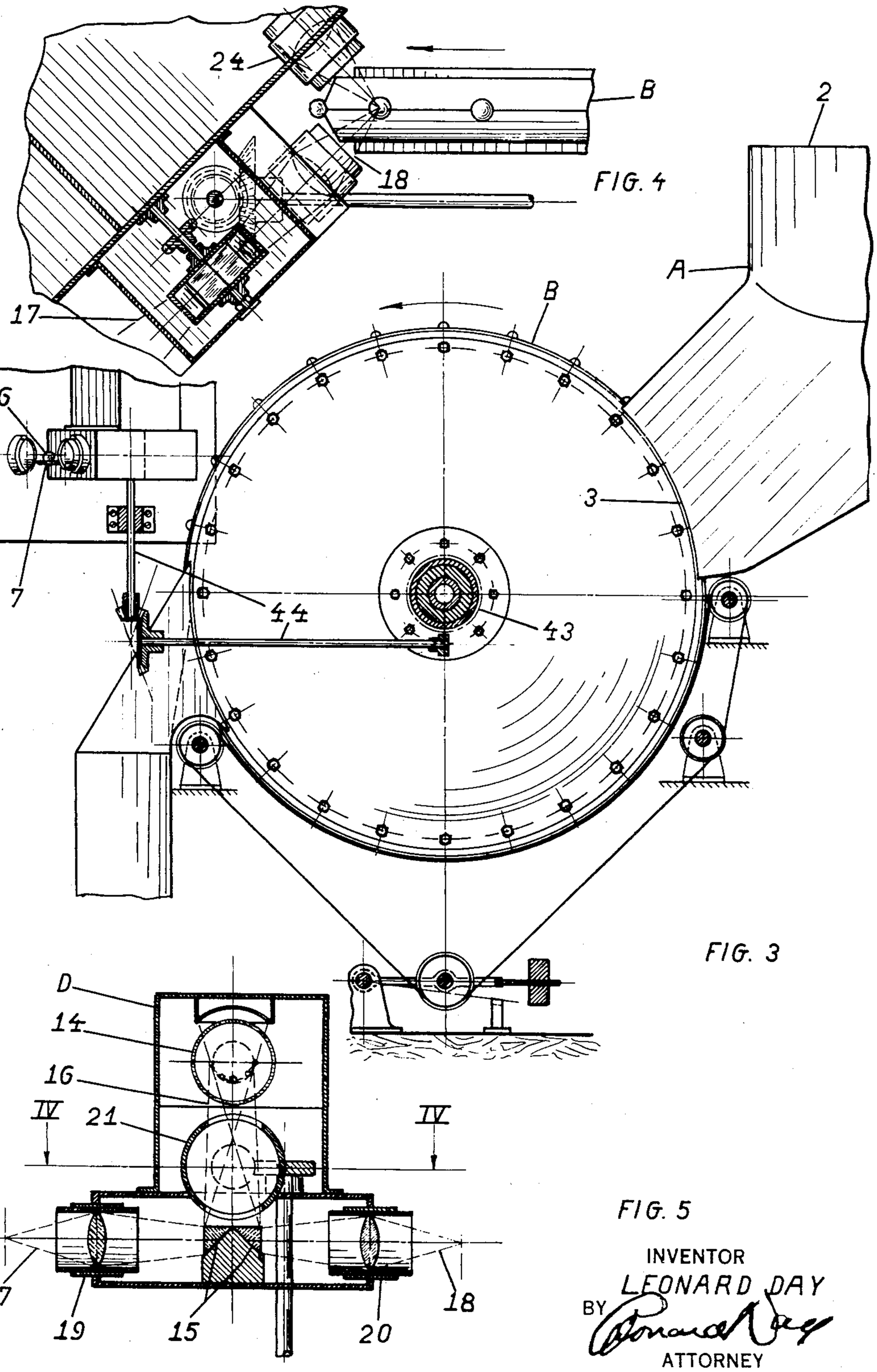

FIG. 4

FIG. 3

FIG. 5

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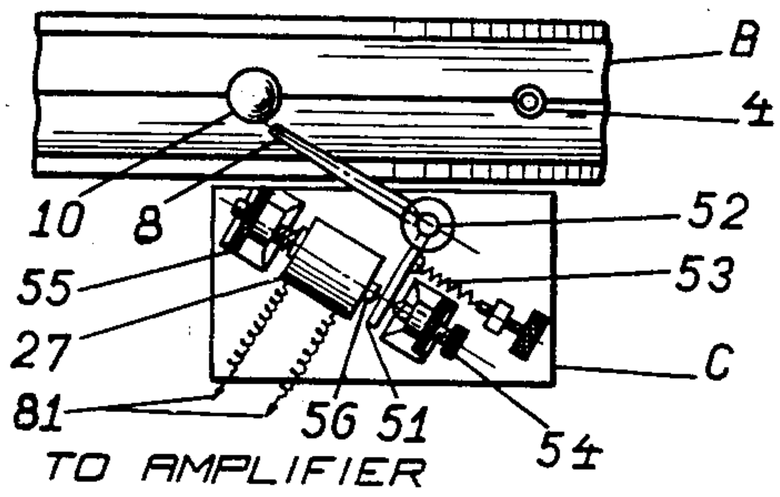

FIG. 7

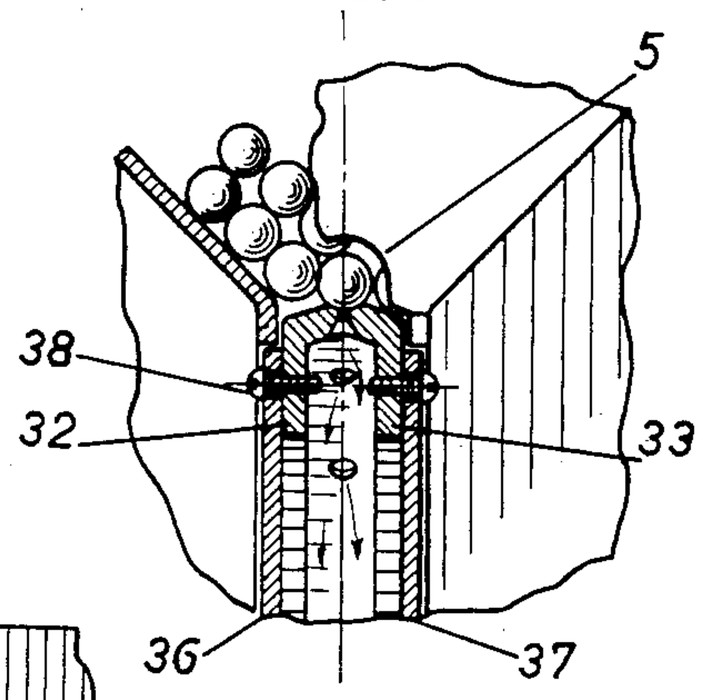

FIG. 6

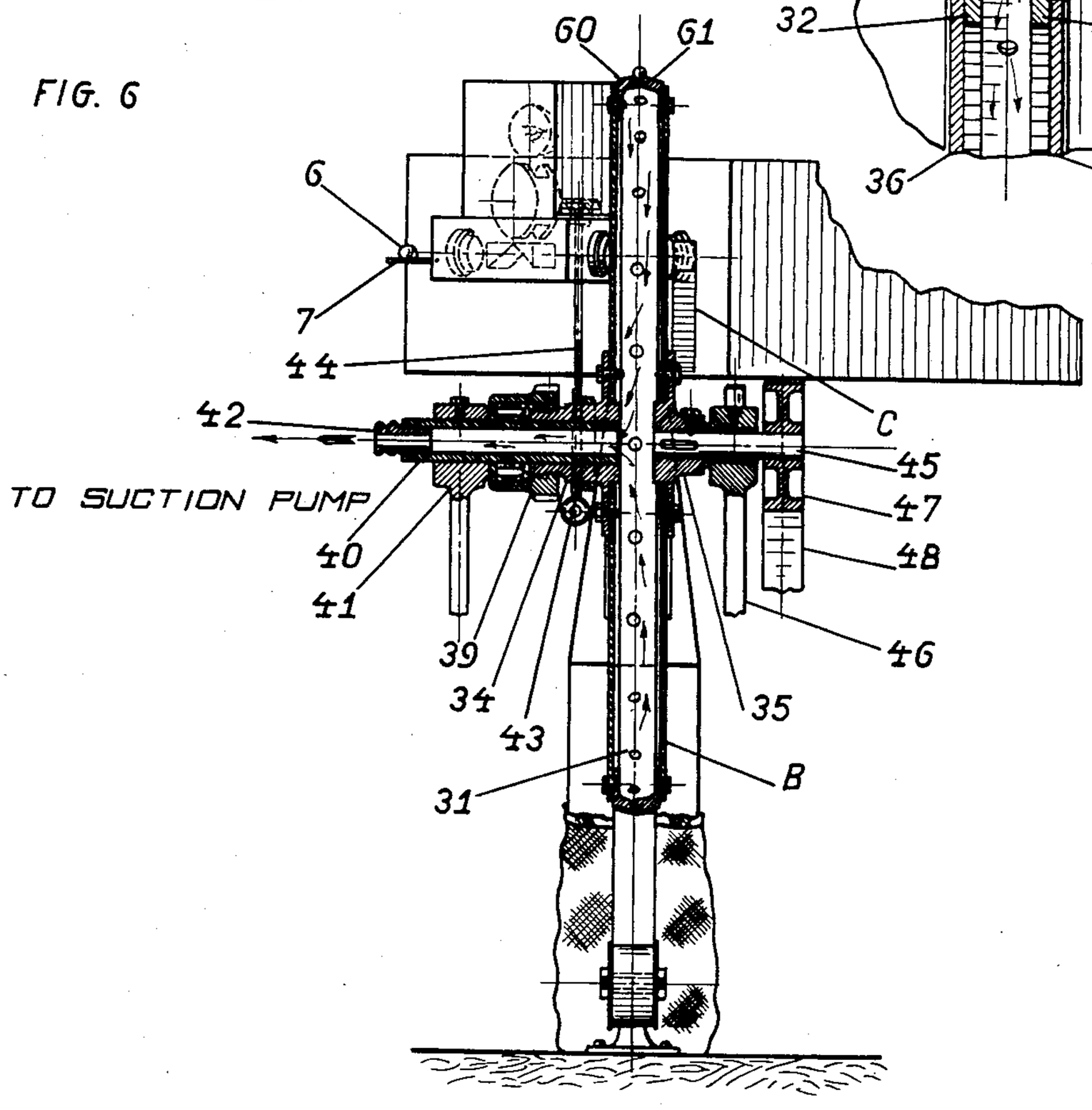

FIG. 8

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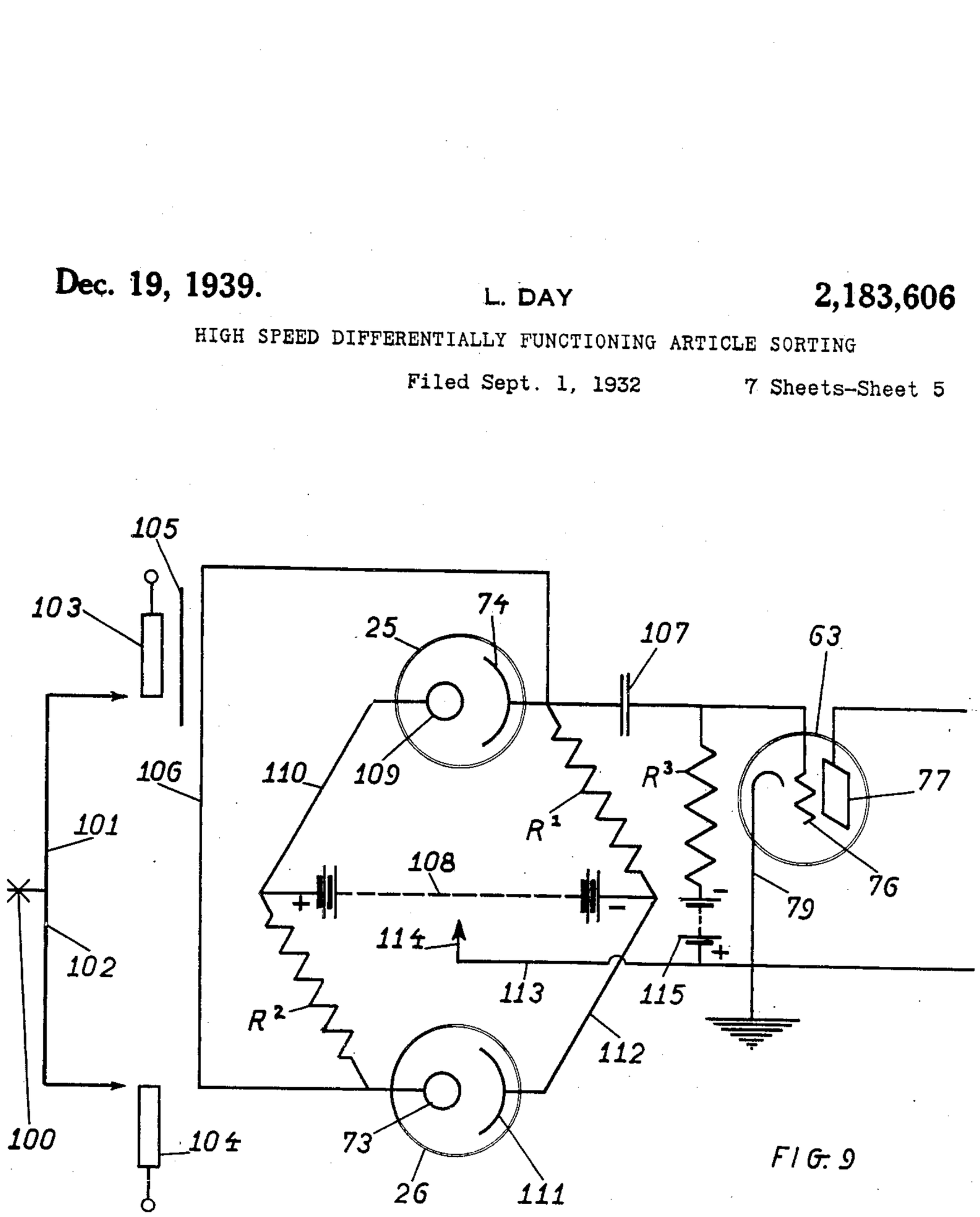

FIG. 9

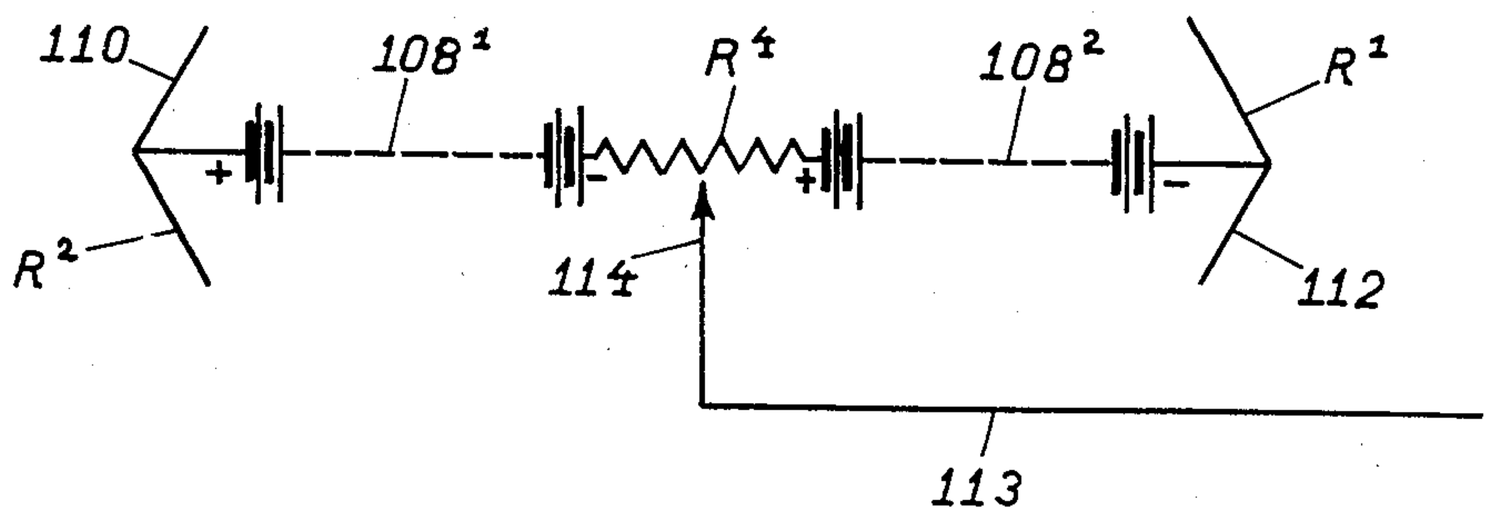

FIG. 10

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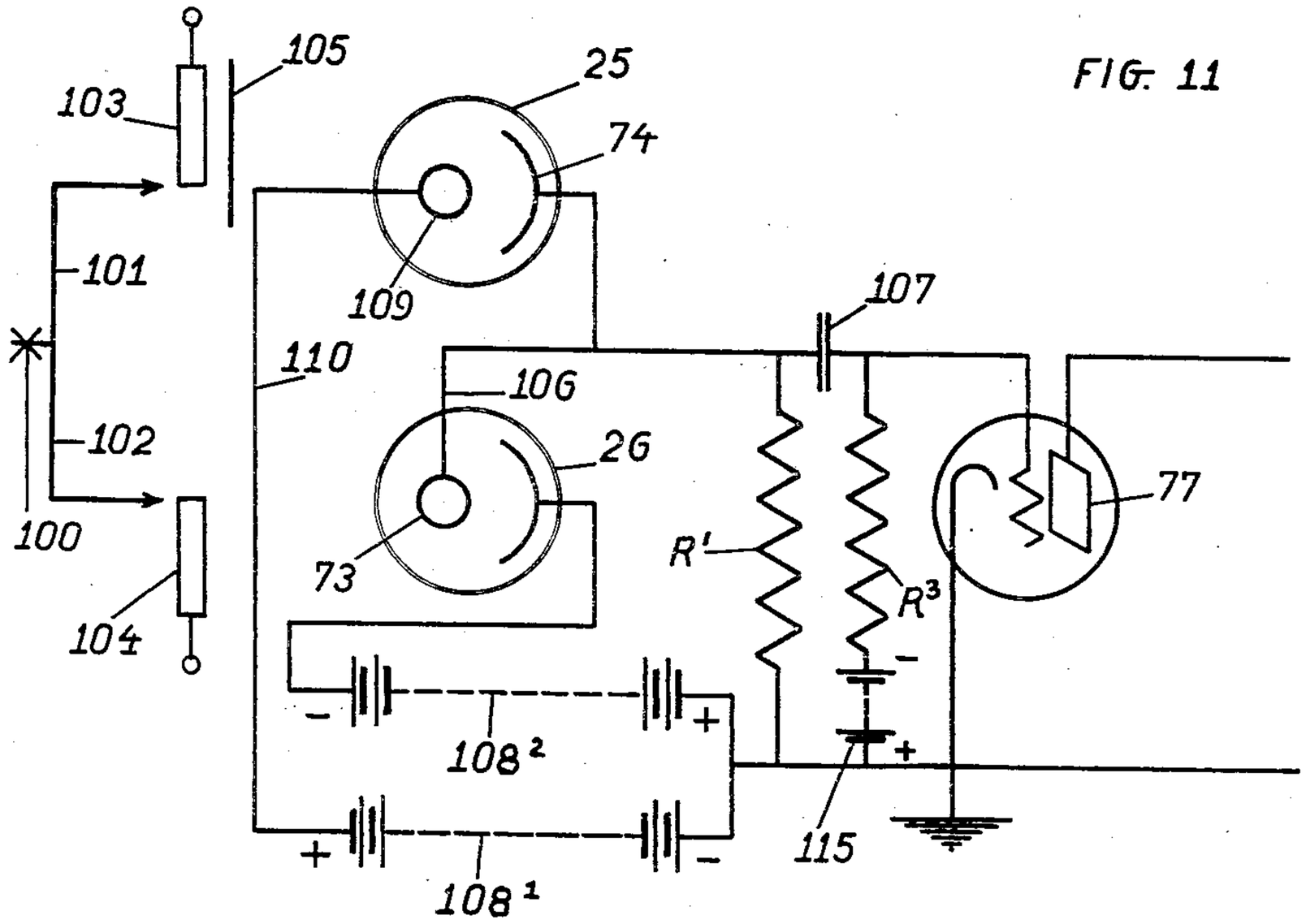
FIG. 11



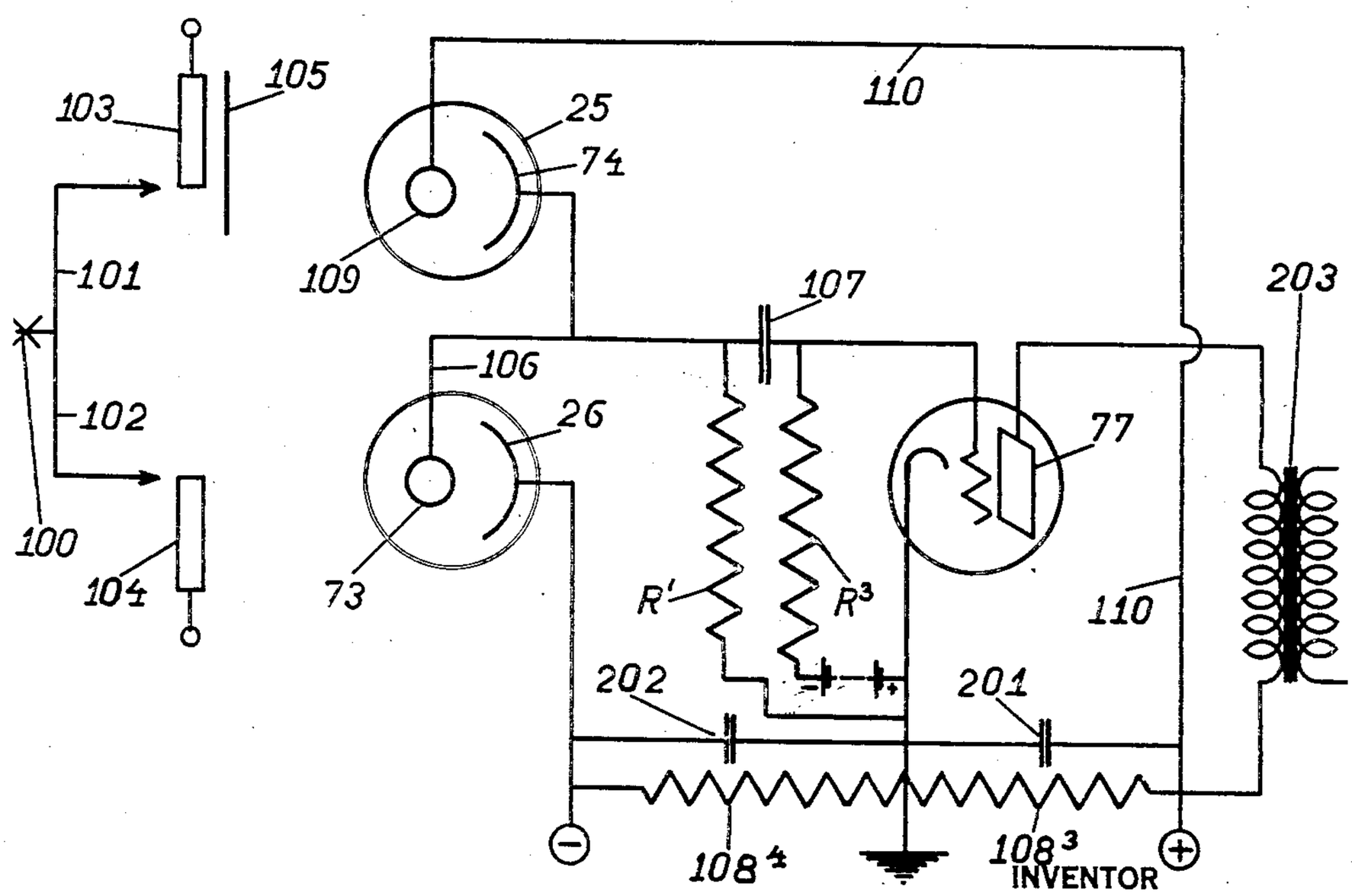


FIG. 12

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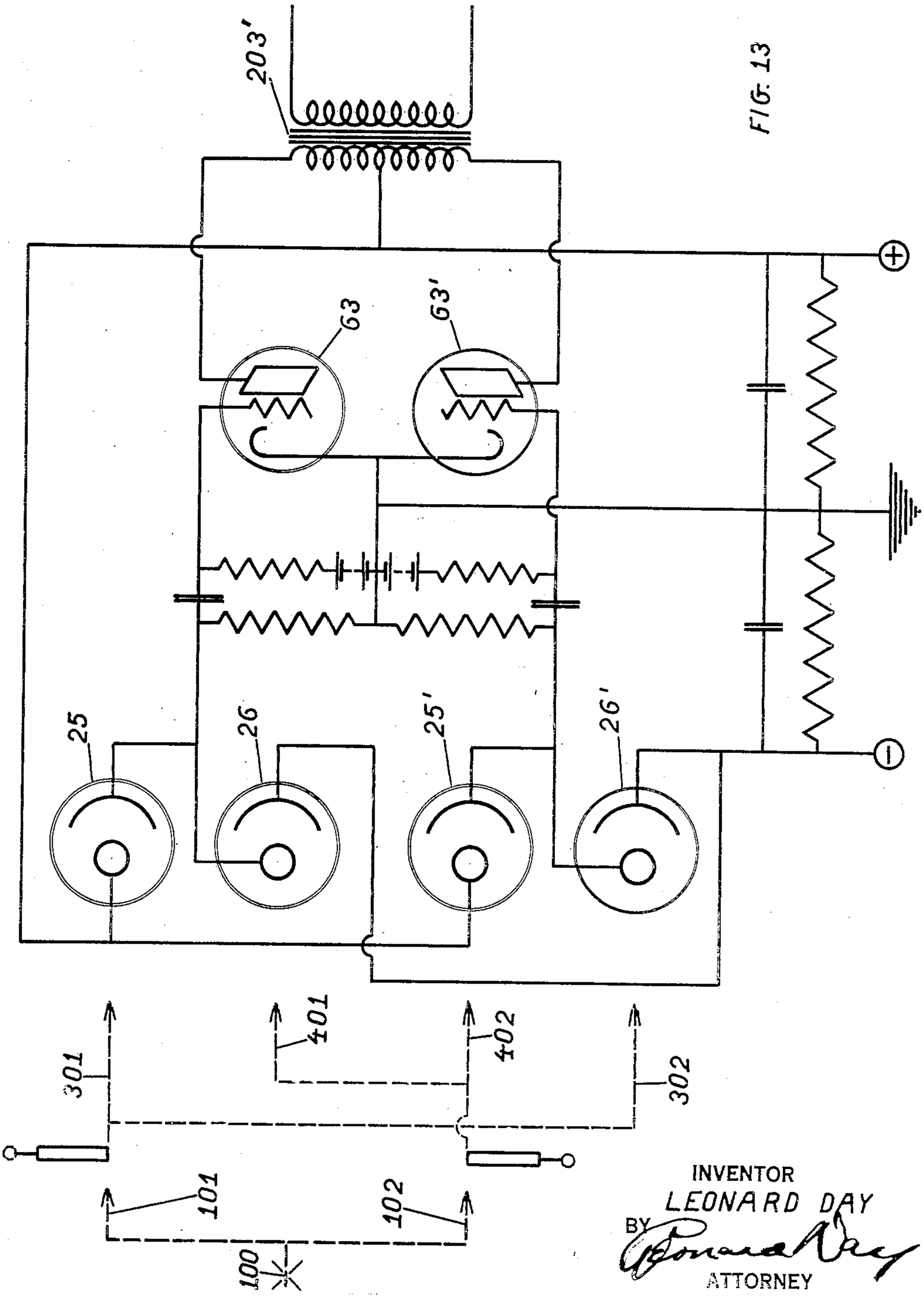
FIG. 13



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Patented Dec. 19, 1939

2,183,606

UNITED STATES PATENT OFFICE

2,183,606

HIGH SPEED DIFFERENTIALLY FUNCTIONING ARTICLE SORTING

Leonard Day, New York, N. Y.

Application September 1, 1932, Serial No. 631,321

17 Claims. (Cl. 209—111)

This invention relates to article sorting and preferred means and methods useful for sorting articles. More particularly, the invention relates to high speed sorting.

An object of the invention is to provide an improved circuit useful for high speed response to the differential between two light excitations. In this connection, it is a primary object to make the subtraction between the two exciting light effects as immediately as possible without permitting the introduction of distorting influences.

A further object of the invention in its embodiment as an article sorter is to insure a high speed dependable comparative test of light values between a standard sample and the articles to be compared therewith.

It is a further object to limit the mechanical movement of the necessary movable parts to effect sorting to the instances when there is a substantial difference of light value in the articles to be sorted from the standard of comparison. In other words, it is an object to permit the unaltered passage of a stream of standard articles through the apparatus until an off-color article is under test, whereupon then only is apparatus set in motion to discard the non-standard article.

A further object of the invention in article sorting is when recourse is had to a suction wheel for conveying the articles to be sorted to effect a closing of the suction seats which are not actually covered by an article to be sorted.

A further object of the invention is to adapt the photoelectric and electric apparatus with relation to the light source in such a way as to eliminate the effect of variation of intensity in the light source, making possible the utilization of an alternating current operated electric light.

A further object of the invention is to produce article sorting apparatus which is substantially independent for the accuracy of its performance from the speed of feed of the articles to be sorted, but in connection with the embodiment of this invention in article sorting apparatus, the principal object is the speeding up of the operation of article sorting many times any speed heretofore obtainable in such apparatus.

Further objects of the invention will be apparent from the accompanying claims which are directed to illustrative embodiments described in the following specification in connection with the accompanying drawings, all of which are presented for purposes of illustration and not limitation. It is appreciated that many features of the invention have high use value in other combinations than those illustrated and described herein, for example, the conveyor mechanism of the sorting apparatus has usefulness in other photoelectric assemblages than those illustrated.

In the drawings, Fig. 1 is a front elevation partly in vertical cross-section and partly diagrammatic illustrating the invention in a machine for sorting beans; Fig. 1A is a plan view of the tension idler shown in elevation in Fig. 1; Fig. 2 is a plan view partly in horizontal section and partly in diagram of the same; Fig. 3 is a view corresponding to Fig. 1 from the rear, with parts broken away; Fig. 4 is a fragmentary sectional view directed particularly to the optical system and taken on a plane through line IV—IV of Fig. 5; Fig. 5 is a section in elevation through the plane of line V—V of Fig. 2; Fig. 6 is a detail of the magnetic kick-off for the sorter; Fig. 7 is a detailed cross vertical section with parts broken away showing the suction pick-up for the articles to be sorted; Fig. 8 is a view in side elevation and partly in vertical section looking from the left of Fig. 1; Fig. 9 is a circuit diagram of one form of differential circuit which is useful both generally and in its application to this sorting machine; Fig. 10 is a modification of the circuit of Fig. 9, the diagram being shown with parts broken away; Fig. 11 is another form of differential circuit of approved character; Fig. 12 is still another form of circuit showing its application to a rectified alternating current source; and Fig. 13 is a circuit embodiment for initiating a full wave and embodying the principles of the circuits previously illustrated.

Referring more specifically to the embodiments illustrated, A indicates a reception and delivery hopper for the beans 1, or other articles to be sorted, into the open mouth 2 of this hopper. There may be a continuous inflow of the beans from a larger reservoir. A suction carrier wheel B cooperates with the hopper A and forms a closure for the arcuate open delivery mouth 3 thereof. The beans 1 seat themselves one by one on a suction socket 4 and emerge carried on the periphery of the wheel B from the limited delivery opening 5. The beans that are carried by the wheel B are both good and bad, the demarcation between good and bad being determined by color. The test of relative goodness is made between each bean progressively carried by the wheel B and a standard or bogey bean 6 mounted stationary on a suitable support 7 in proper relation to the optical system later to be described.

If one of the beans 10 being carried by the suction wheel B for test does not match up to the standard bean within the desired limits, the

kicker lever 8 of the electrically operated discharge mechanism C throws it off of its suction seat 4 and causes it to fall over the discard barrier 9. Standard beans seated on the suction seats pass through the notch 11 of this barrier 9 and are stripped from their suction sockets by the stripper 12 to fall into the bag 13.

It is preferred that a single source of light 14 of an optical system D be split into two beams by reflecting prisms 15 in such a way that the single beam 16 from this source of light emanating in one direction from the source of light be utilized by splitting into two test beams 17 and 18 by means of suitable lenses such as 19 and 20. The beam 18 is used to make the light test of the progressing articles and the beam 17 is used to make a simultaneous light test each time of the standard bean. In the optical system, a shutter 21 is synchronized with the suction wheel B so that light from the source 14 is limited solely to the time that a moving bean occupies the position of the focussed light beam 18 and, of course, the standard bean is subjected to light for the same time interval. In seating the standard bean, the portion of its surface which presents the desired color should be contacted by the focussed beam 17, while the moving bean under test has a considerable portion of its surface swept by the test beam 18. This eliminates the missing of a substantial spot on the exposed surface of a bean to be tested.

Collector lenses 23 and 24 pick up the reflected light respectively from the test bean and the bean to be sorted and project this light respectively upon two photoelectric cells 25 and 26. These photoelectric cells are combined and connected, preferably in accordance with the principles of my distortionless instantaneously differentiating circuit, and thence to an amplifier system which receives and amplifies solely the differential of the light effect upon these two cells. This functioning is such, for example, that if one of the beans 10 under test is enough darker than the standard to warrant rejection, an electrical impulse energizes the magnet 27 of the discard C to throw the kicker arm 8 into the path of the rejected bean 10, otherwise the bean 10 clears the rejector arm 8 and passes safely through the sorter. The details of this electrical circuit will be described more fully later.

The actual embodiment of the apparatus used for picking up and discharging the articles to be sorted may take on any prefered embodiment, and I have endeavored to illustrate the invention in the present drawings in such a way as to bring out with clarity some of the more important functioning features. In the construction shown, the suction wheel B may be formed with a cast metal rim 30 in which the suction sockets 4 are little more than externally reamed holes opening up into the interior cavity 31. Flanges 32 and 33 of this cast metal ring may be secured to two hubs 34 and 35 respectively by two sheet metal discs 36 and 37 by any suitable means such as screws 38. The hub 34 is shown tubular and fitted at its outer end with a stuffing box 39 sealing off the inner cylindrical tube 40 which serves as a bearing for the hub and may be mounted in the bracket 41. The nipple 42 is connected to an exhaust pump tending to maintain a vacuum within the wheel cavity 31. A gear 43 is fitted to the hub 34 to drive the synchronizing gear train 44 for the cylindrical shutter 21. The opposite hub 35 carries the bearing spindle 45 working in the bracket bearing 46 and carrying the drive pulley 47 which may be driven through a belt 48 from any suitable source of power such as the electric motor 49. The control rheostat 50 controls the motor 49 to vary its speed which may be desired to adjust for the best performance in connetcion with different kinds of articles to be sorted. By reason of the synchronizing of the test light exposure with the duration of an article to be sorted in a certain position, and further, on account of my differential functioning of the light test, it is immaterial within wide limits at what speed the articles to be sorted are passed throught the optical system. In fact, the only limitation upon the speed of the apparatus is the speed at which the kick-off apparatus C can function. This has been designed so that a very limited movement of the arm 8 effects a discharge of a reject and a consequent very limited return movement is required.

In the form illustrated, a simple low impedance magnet, when its magnetism is strong enough, attracts the armature 51 which, with the lever 8 in bell-crank formation, is mounted on the pivot 52. An adjustable retractile spring 53 is preferably employed. Also, an adjustable back stop 54 for the armature 51 and an adjusting device 55 for positioning the poles 56 of the magnet 27 relatively to its armature 51. These adjustments permit the apparatus to be adjusted for various sizes of articles to be sorted and, for small regularly shaped articles like peas, enables the device to be set for an almost infinitesimal movement between reject position and normal position.

By varying the pull of the retractile spring 53, an adjustment may be made in the amount of difference in color required to reject an article. This adjustment can also be made by varying the air gap between the poles of magnet 27 and its armature, although it is prefered that this air gap be adjusted to a minimum. In all cases, the electrical activating force is limited to a multiple of the difference in light value between the article to be acted on and the standard article. This functioning of the machine is of great importance, eliminating all fine adjustments necessary when a machine must function in accordance with some particular light value from the article to be selected.

Although I lay no claim broadly to the use of suction in a carrier for articles, I do lay claim to the improved form of suction carrier illustrated and described. One noteworthy feature of my suction carrier is the fact that all the suction sockets in the suction wheel B are open to the central vacuum chamber 31, and no one is fitted with a valve, but those not closed by an article seated in the socket are efficiently closed by means of the flexible apron 57 which rides against the periphery of the rim 30 and is carried over idlers 58 and the tensioning idler 59. It is preferred that the rim 30 be beveled to form the conical surfaces 60 and 61 on the principle of a pulley carrying a flat belt so that the apron or belt 57 tends to stay on the rim rather than fall off. By this simple expedient, as many of the suction sockets 4 which are not closed by an article to be sorted, are closed to maintain the vacuum within the chamber 31.

A grounded shielding box 62 of metal is preferably employed to mount the photoelectric cells and the first amplifier tube 63, and it is preferred that a partition 64 be placed between the photoelectric cells 25 and 26 to prevent any strad-

dling of the light. It is also to be understood that extension hoods may be provided to shield the article to be tested by the light beam 18 and the standard article 6 to be tested by a light beam so that no light except that reflected from the articles standard and that to be tested can reach the photoelectric cells.

In my differential circuits which function to amplify only the differential, it is to be noted that in all circuits the cathode of one photoelectric cell is directly connected by a short conductive connection to the anode of the other photoelectric cell and that these two directly coupled electrodes are then in turn connected by some suitable link means directly to the grid of the first amplifier tube, and that in addition, a stabilizing high resistance tending to maintain a normal average condition for both photoelectric cells is provided. In this way, the anode of a photoelectric cell and an opposite electrical effect in response to light to the electrical effect of the cathode by reason of their direct coupling produces an instantaneous subtraction of these effects practically at the source and permits only the differential of these effects to affect the grid of the first amplifier tube and this effect is an instantaneous effect following from the potential differential between the two photoelectric cell electrodes and not dependent upon any fall of potential across a resistance which can take place only when there is a dynamic flow of current. I utilize dynamic flow of current across the high resistance merely as a stabilizer.

Many years of experimentation and attempts to employ circuits of others finally led to this circuit.

In my circuit, the first diagram of which is that of Fig. 2, one source of potential 70 is the activating battery for photoelectric cell 26 and in close circuit therewith through high resistance R which should be in the order of megohms. Source of potential 71, likewise shown in the form of a battery, is the activating source of potential for photoelectric cell 25 and is in close circuit therewith also through resistance R, so that the point 72 is common to these two circuits and is located in the direct conductive connection between anode 73 and cathode 74, and by wire 75 is directly connected to grid 76 of the first amplifier tube 63. The common point between batteries 70 and 71 is connected by wire 78 to amplifier tube cathode 79 and to ground, to which is likewise grounded the metal casing 62. In functioning, two instantaneous light shots, one falling upon the photoelectric cell 25 and one falling upon the cell 26, cause instantaneous liberation of electrons from the cathodes which flock to their cooperating anodes. This functioning is as nearly instantaneous as any phenomenon can be. The photoelectric cells are true photoelectric cells, not selenium cells or variable resistance devices of any kind. They are the kind in which the cathode has the power to emit electrons in proportion to the light reaching its surface. For example, in functioning, suppose a million electrons are emitted from cathode 74 and 1,200,000 are received at the same time by anode 73, this cathode and this anode constitute practically the same small capacity electrostatic system and there is instantaneously the net result of 200,000 electrons more than before the effect of the light shot took place. This excess of 200,000 electrons represents an increment of negative potential value for this system, of which the grid 76 is a part. The differentiating or subtracting has been done automatically at the prime source, namely, the electrodes of the two photoelectric cells, and this potential change exercises its controlling effect as is usual for grids of amplifier tubes. The resistance R for this instantaneous functioning plays no part whatever. It does, however, later play a part. In the interval before another light shot comes, it permits a dynamic change of flow of electricity measured by the change of potential and causes the photoelectric cells to reach or approach their normal condition. The functioning takes place over again when a second pair of light shots are applied. The plate circuit from the first amplifier tube 63 is carried into any usual form of amplifier E, which, of course, includes suitable source of electric energy. Its terminals 30 may be led directly to the terminals 31 of the discharging magnet 27. The amount of amplification may be increased to whatever is desired because all that is to be amplified is the exact differential which was created at the prime source. Thus, only where there is a difference in light value between the standard article and the article to be sorted is the sorter magnet 27 activated. If it is desired, however, slight differences in light value may be annulled in the device C by seating it so that a substantial current impulse is required for its operation.

In Figs. 9 and 10, one convenient way of balancing the differential adjustment of the two photoelectric cells 25 and 26 is illustrated. In these diagrams 100 indicates the original source of light which branches into the beams 101, 102. 103 and 104 are shutters which may cut off an adjusted amount of the light that can reach the respective photoelectric cells 25 and 26, whereby a balance may be attained. This is one way of compensating for slightly varying characteristics of the photoelectric cells.

105 indicates some means for modulating the light beam 101. It may be the article to be sorted, or it may be anything capable of varying, interrupting or modulating the light.

As to the circuit itself, the anode 73 of cell 26 is conductively connected to the cathode 74 of cell 25, preferably by a length of wire 106. These three things form an insulated isolated electrostatic system of small capacity which, in turn, is linked by any suitable link means to the grid 76 of the first amplifier tube 63, the cathode 79 of which is grounded. The link means employed is a small capacity condenser 107, although it may be a conductor. A battery 108 is connected at its positive terminal directly with the anode 109 of cell 25 by a suitable wire 110. The minus end of the battery is connected to the cathode 111 of cell 26 by wire 112. The cathode 79 of the first amplifier tube is connected by wire 113 and adjustable contact finger 114 substantially to the middle point of battery 108. For this circuit two resistors are required, each in the order of megohms. R^1 connects the minus end of the battery to the aforementioned isolated electrostatic system, that is, to wire 106. Resistance R^2 connects the positive end of the battery to this same system. It should be noted that this system is therefore connected through these two resistors in parallel and through the battery 108 to ground and to the amplifier cathode 79. This provides an electrical fulcrum which prevents this electrostatic system from becoming overcharged and tends to maintain it at a uniform potential for any steady excitation, al-

though the resistors are too high to permit of any substantial dynamic flow. These resistors also respectively complete the local exciting circuits for the photoelectric cells from battery 108, so that for no light on the photoelectric cells, the full battery potential is applied across from anode to cathode of each photoelectric cell. Both the resistors R^1 and R^2 are preferably adjustable to aid in attaining the desired degree of adjustment for my differential effect.

A leak R^3 between cathode and grid of the first amplifier tube is illustrated and a biasing battery 115.

In functioning in response to light, if exactly equal light impulses reach the two photoelectric cells 25 and 26 simultaneously, cathode 74 abstracts from its local electrostatic system the same number of electrons that are introduced into it by discharge of the cathode 111 on its anode 73 of the other cell. As a result, no impulse is passed through the condenser 107 to effect the potential of the grid 76. No change takes place in the circuit for plate 77. If, however, more light reaches the cell 25 than does the cell 26, more electrons are abstracted from the system 106 than are driven into it and it becomes instantaneously more positive. This more positive impulse is transmitted through the condenser 107 to the grid 76 to effect an amplified current impulse in the plate circuit 77. If, on the reception of two light shots, more light reaches cell 26 than reaches cell 25, less electrons are abstracted from system 106 than are received by it and the system 106 becomes more negative. This negative impulse is transmitted through condenser 107 to grid 76.

In Fig. 10, instead of employing one battery 108, two equal batteries 108^1 and 108^2 are employed, linked together through resistor R^4 with which the finger 114 adjustably contacts to effect adjustment of the working potential applied to the cells for a dynamic condition when a certain amount of light is being applied to both cells, otherwise it is to be understood the rest of the circuit is as shown in Fig. 9.

In Fig. 11, the hookup is the same as in Fig. 9 except that but one resistor R^1 is employed, and two separate batteries 108^1 and 108^2 are employed.

In Fig. 12, the same circuit as that shown in Fig. 11 is illustrated except that the batteries 108^1 and 108^2 are substituted by resistors 108^3 and 108^4 of an alternating current rectifying system, which are assisted by condensers 201 and 202 in parallel with the resistors. This circuit shows a transformer 203 operating from the plate circuit 77 of the first amplifier tube.

In Fig. 13, a double differential push-pull arrangement is illustrated. The single light source first branches into branches 101 and 102, the differential effect of which is to be amplified. Each of these branches is again branched by suitable optical system into two sub-branches 301 and 302 for the original branch 101 and 401 and 402 for the other. Here we have not only the differentially connected photoelectric cells 25 and 26 but another pair 25′ and 26′. In this array, the cells 25 and 25′ do not receive the same kind of light. 25 and 26′ are the cells that receive the same kind of light and 26 and 25′ the same light of a different character. The same circuits are employed in symmetry as that illustrated in Fig. 12, and the differential effect functions in the same way, that is, between cell 25 and cell 26 and between cell 25′ and cell 26′, but the differential between the cells 25 and 26 has a different effect upon amplifier tube 63 than it does upon the twined amplifier tube 63′, but these tubes 63 and 63′ are connected oppositely into the primary of transformer 203′ so that the current impulse is double.

In each of the circuits the subtracting of light effects is caused to take place at the source of the transformation of light into electricity, that is, right at the electrodes of the photoelectric cells, while in addition, a stabilizing resistance for the slow dynamic flow of stabilizing energy is provided, itself connected in such a way that the instantaneous electrostatic potential changes on the interlinked anode and cathode of the twinned photoelectric cells are instantaneously conveyed to the appropriate grid of the first amplifier tube without waiting for a flow of current across the resistor. In connection with this subject, it is well to bear in mind that although electricity flows at the speed of light, a finite time is required for a given quantity of electricity to flow through a high resistance path capable of carrying only a limited quantity of electricity. A good concept for this theory is a pen in which a large gate which has one small gate to pass but one sheep at a time confines a number of sheep with their noses against the gate. If it takes K time for one sheep to progress its own length, and there are one thousand sheep, if they go one after the other through the small gate, it takes one thousand K units of time to change the sheep potential beyond the gate one thousand, but if the large barrier is lifted so that all the sheep march forward together, it takes only K units of time to effect this thousand potential change. The resistors in my system correspond to the one sheep at a time gate, while the instantaneously functioning link means between the electrostatic system and the grid of the amplifier tube is a free path allowing all the sheep electrons to progress abreast. By an arrangement of this sort, tremendously high speed response to extremely small time light shots may be accomplished and the recovery to normal condition may be spread over a longer period of time represented by the interval between the light shots.

In the application of my double system shown in Fig. 13 to article sorting, there is an advantage present. The two beams 401 and 402 may be reflected light beams from different positions on the article to be sorted coming into the photoelectric cells at the same time, while the two beams 301 and 302 may likewise come from opposite sides of the test article or because the test article may be positioned to present any area of its surface desired, it may be merely a single beam branched. In this viewing of an article to be sorted from two sides, the mechanism need not be changed from that illustrated in Figs. 1, 2, 3, 4, and 5 except that there should be a duplication of the viewing lenses such as 24, the axes of which contact the article to be sorted at different localities.

Even in the circuit of Fig. 13, it should be noted that my control of a first stage amplifier tube is direct from the electrostatic systems and is not dependent upon a dynamic flow of current through a resistance. No distorting devices are employed except to amplify the differential impulse delivered by the plate circuits of the first stage amplifier tubes.

What I claim and desire to secure by United States Letters Patent is:

1. In a high speed sorter for articles, a photoelectric cell differential device comprising two photoelectric cells each having an anode and a cathode; a conductive link between the anode of one photoelectric cell and the cathode of the other photoelectric cell; a link means connecting said link with an amplifier system; a source of light; a separate source of electric potential for each photoelectric cell; a high resistance; circuits for said photoelectric cells and separate sources of potential including said high resistance in common; a standard article for purposes of light value comparison; means for conveying an article to be sorted; means for illuminating said standard article and said article to be sorted from said source of light; means for exposing said photoelectric cells simultaneously respectively one to light from said standard article and the other to light from the article to be sorted; and rejector means responsive to a substantial difference of light excitation of said photo-electric cells.

2. In an article sorter, a rejector; means for obtaining an electrical differential between the same light reflected from an article of comparison and an article to be sorted; means for amplifying the same; electrical means for operating said rejector solely in response to said electrical differential from a difference in reflected light values.

3. In an article sorter, a pneumatic carrier having suction sockets each for conveying an article to be sorted; a rejector arm normally cleared by the articles to be sorted; electrical means for moving said rejector arm to dislodge said article from a suction socket; photoelectric means for producing and amplifying solely the difference in light value between the article to be sorted and a standard of comparison; and means for applying a differential light test to the article to be sorted prior to the time it reaches said rejector arm.

4. In an article sorter, in combination, means for conveying a plurality of articles past a preselected point, a source of light, a beam-splitting means adapted to convey light therefrom to said predetermined point, and another beam to a standard, a plurality of photocells respectively cooperating with said sortable articles and said standard, and means actuated by said photocells differentially and jointly to sort articles carried past said predetermined point.

5. In article sorting, the method of compensating for irregularities of sorting light which comprises causing light from a single source to impinge upon two shaded articles for the same unit of time, to be reflected therefrom upon a pair of photocells and the further step of operatively differentiating the effect of light upon the respective photocells upon an amplifier system and subsequently to said unit of time moving a massful ejector solely in response to an amplified difference in the light value from said two articles.

6. In an article sorter, means for conveying articles to be sorted at high speed; a standard light reflector for comparison; a differential photoelectric cell combination; means synchronized with said conveying means for intermittently and simultaneously transmitting light from the same source to said standard light reflector and to an article to be sorted and simultaneously transmitting reflected light from said standard light reflector and from said article to be sorted respectively to the different photoelectric cells of said differential photoelectric cell combination; means for amplifying solely the differential electrical effect resulting from any difference in the light values reflected from said standard light reflector and from said article to be sorted; and rejector means operative to reject said article from said conveying means a time interval later than when said article was exposed to the selecting light, said rejector means being operated solely from said amplified differential electric effect of said differential photoelectric cell combination.

7. In a high speed small article sorter, rotary suction means having peripheral suction sockets for picking up and progressing one article to a socket; two photoelectric cells; separate sources of electricity and separate circuits including a high resistance connecting said photoelectric cells, said high resistance being connected at one end to the anode of one cell and the cathode of the other cell; a triode amplifier with its grid linked to said differential photoelectric cell circuits at the junction of said high resistance, anode and cathode; a movable article ejector, electromagnetic means operable solely by amplified photoelectric cell differential effect; means for applying two light beams to said photoelectric cells respectively in synchronism with the movement of a suction socket and for causing one beam of light to be controlled by a light controlling function of the article to be sorted and for controlling the other beam of light in accordance with the standard light value function.

8. In an article sorting mechanism, a conveyor, means for placing articles to be sorted on said conveyor, an article of comparison and which may comprise one selected from the group of articles to be sorted, means capable of maintaining some of the articles on said conveyor for a predetermined period, electrical means for actively differentiating between the article of comparison and the articles to be sorted and a device capable of being actuated by said electrical means for removing articles from said conveyor at a period shorter than said predetermined period but later than the time of active differentiation.

9. In an article sorter, in combination, an article carrier having means for conveying a series of articles to be sorted past a sorting point, a rejector arm normally inactive with respect to the series of articles, an electrical means for moving said rejector arm to dislodge articles from said carrier; a standard article for comparison purposes, and photoelectric means for distinguishing between different ones of the sortable articles having different characteristics, comprising a light source for illuminating the series of articles to be sorted and the standard article, a pair of photo-cells respectively receiving light, one from the standard article and one from each of the successive articles being sorted, a link circuit between said photo-cells and said electrical means for moving said rejector arm, having members therein for obtaining a differential of the responses of said photo-cells for the control of said rejector arm and a shutter mechanism cooperating between said light and said articles for simultaneously cutting off light to said standard article and to the point where said sortable articles are sorted during the time of movement of the successive articles to, and away from, the sorting point.

10. In an article sorter, in combination, an article carrier having means for conveying the

series of articles to be sorted past a sorting point, a rejector means normally inactive with respect to the series of articles, an electrical means for moving said rejector means to dislodge articles from said carrier; a standard article for comparison purposes, and photoelectric means for distinguishing between different ones of the sortable articles having different characteristics, comprising a light source for illuminating the series of articles to be sorted and the standard article, a pair of photo-cells respectively receiving light, one from the standard article and one from each of the successive articles being sorted, a shutter mechanism cooperating between said light and said articles for simultaneously cutting off light to said standard article and to the point where said sortable articles are sorted during the time of movement of the successive articles to and away from the sorting point, and a light splitting prism cooperating with said light and shutter to direct substantially equal beams of light toward said standard article and said sortable articles.

11. In an article sorter, an article carrier for conveying sortable articles, an illuminant cooperating therewith, a pair of substantially similar light paths from said illuminant, one path leading to the point on said pneumatic carrier past which the sortable articles travel, the other path leading to a standard article, a common shutter for interrupting both light paths during movement of sortable articles to and from the sorting point, a pair of photo-cells respectively cooperating with said substantially similar light paths, one to receive light from a sortable article and another to receive light from a standard article, and differentiating circuits cooperating with said photo-cells.

12. In an article sorter, an article carrier for conveying sortable articles, an illuminant cooperating therewith, a pair of substantially similar light paths from said illuminant, one path leading to a point on said pneumatic carrier past which the sortable articles travel, the other path leading to a standard article, a common shutter for interrupting both light paths during movement of sortable articles to and from the sorting point, a pair of photo-cells respectively cooperating with said substantially similar light paths, one to receive light from a sortable article and another to receive light from a standard article, an amplifier mechanism, and bridge connections between said photo-cells and said amplifier adapted to balance the photo-cell responses to reflect light rays from the standard article and similar sortable articles.

13. In an article sorter, a carrier for conveying sortable articles, a plurality of mechanism for removing articles therefrom, one cooperating with a reject receptacle and another with an accept receptacle, an illuminating means and a pair of similar light paths one leading to the said pneumatic carrier and the sortable articles thereon, the other leading to a standard article, a pair of photo-cells respectively responsive to light from the respective articles, a balancing circuit adapted to differentiate the outputs of said photo-cells, an amplifier responsive to differences in output from said photo-cells, and a transformer associated between said amplifier and said reject member for actuating said reject member when a sortable article has a higher light reflection, or a lower light reflection than said standard articles.

14. In an article sorter, a carrier mechanism adapted to convey a series of sortable articles, an illuminant, optical means for focusing light from said illuminant upon said sortable articles and upon a standard article, an auxiliary optical means for focusing light rays from said sortable articles and from said standard article into separate photo-cells, and a shutter mechanism cooperating with said optical systems to deliver pulses of light to said articles when the sortable article is at the focal point of the corresponding optical system, an amplifier, and balancing connections cooperating between said photo-cells and said amplifier whereby no current pulse is delivered to said amplifier during the changes from light to dark, and pulses are delivered when the conductivities of said photo-cells are caused to be different by different reflective powers of said standard article and said sortable articles.

15. In an article sorter, means for comparing light from a standard article and a sortable article, comprising a pair of photo-cells, a shutter mechanism cooperating therewith, an amplifier mechanism and means for making said amplifier non-responsive to the alternate periods of light and darkness produced by said shutter, comprising a balancing circuit between said photo-cells and said amplifier.

16. In an article sorter, means for comparing light from a standard article and a sortable article, comprising a pair of photo-cells, a shutter mechanism cooperating therewith, an amplifier mechanism and means for making said amplifier non-responsive to the alternate periods of light and darkness produced by said shutter, comprising a balancing circuit between said photo-cells and said amplifier, and a reject mechanism cooperating with said carrier actuated by said amplifier to reject an article having unduly high or unduly low reflective powers.

17. An article sorting system comprising means for conveying articles past a sorting point, means for illuminating said articles at said sorting point, a standard of reference for light reflecting power comparable to normal articles, means for applying light thereto, a pair of photo-cells respectively energized by light from said articles to be sorted and from said standard of reference, means for rejecting undesired articles and means for operating the reject means comprising a magnet, a transformer for the supply of current thereto, an amplifier, and balance circuits for balancing out current pulses to said amplifier and transformer when said articles and said standard have substantially the same light reflecting power and delivering a current pulse to said reject operating magnet and for delivering a pulse of one polarity or another through said transformer to said magnet when there is a difference in light reflecting power.

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