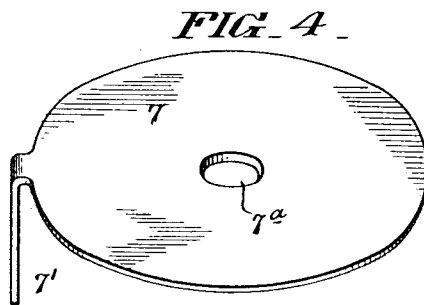
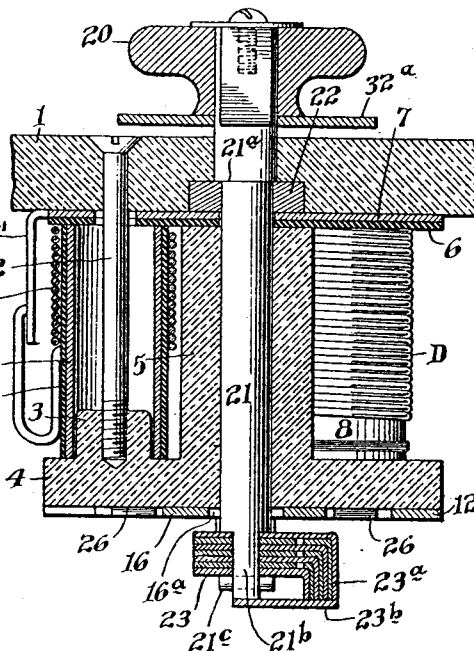


1,104,841.

2 SHEETS—SHEET 1.

FIG. 2.



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RESISTANCE SET.
APPLICATION FILED MAR. 12, 1913.

1,104,841.

Patented July 28, 1914.

2 SHEETS-SHEET 2.

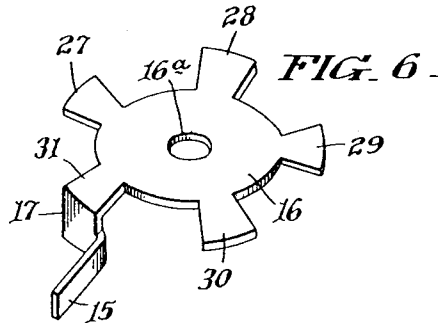
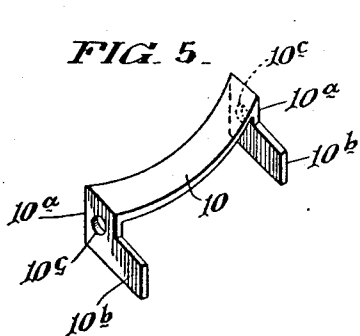
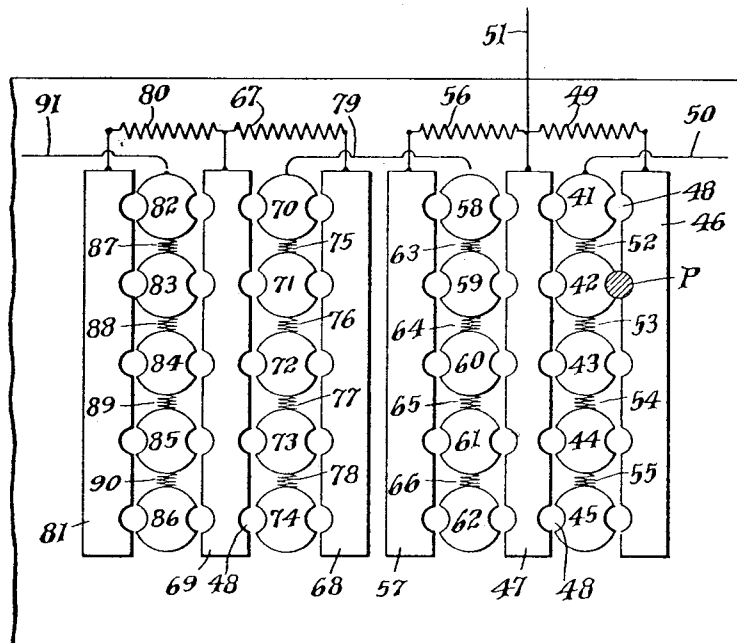


FIG. 7.



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UNITED STATES PATENT OFFICE.

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RESISTANCE SET.

1,104,841.

Specification of Letters Patent.

Patented July 28, 1914.

Application filed March 12, 1913. Serial No. 753,694.

To all whom it may concern:

Be it known that I, IRVING B. SMITH, a citizen of the United States, residing in Ambler, State of Pennsylvania, have invented certain new and useful Improvements in Resistance Sets, of which the following is a specification.

My invention relates to resistance sets, such as decade sets, whereby various amounts of resistance, of preferably known values, may be introduced into an electrical circuit for any purpose, particularly for electrical measurements.

It is the object of my apparatus to provide resistance apparatus of this character which shall occupy small space, and which shall effect an economy in number of parts, in cost of parts, in manufacture and assembly, and which shall insure minimum error arising from variations of contact resistance or connecting leads.

With these objects in view my invention resides in the features hereinafter described and claimed.

For an illustration of some of the forms my invention may take reference is to be had to the accompanying drawings, in which:

Figure 1 is a side elevational view of a form my invention may take when embodied in a so called dial set. Fig. 2 is a cross sectional view, some parts in elevation, of the apparatus taken on the line X—X of Fig. 3. Fig. 3 is a bottom plan view of the apparatus shown in Fig. 1. Fig. 4 is a perspective view, on larger scale, of an element of the apparatus shown in Fig. 1. Fig. 5 is a perspective view of one of the contact elements of the apparatus illustrated in Fig. 1. Fig. 6 is a perspective view of another of the contact elements of the apparatus of Fig. 1. Fig. 7 is a plan view, partially diagrammatic, of a plug set embodying another form of my invention.

Referring first to Figs. 1 to 6 inclusive, a plate or block 1, of hard rubber or other suitable insulating material, may form a support for my resistance set. Extending through the base 1 may be one or more screws 2 threading into lugs 3 upon a plate or disk 4 of suitable insulating material, preferably moldable insulating material

such, for example, as a condensation product. The plate 4 has the central hub or boss 5 which, when the screws 2 are drawn up tight thrusts with its upper end against the plate or sheet 6 of insulating material between which and the base is thereby clamped or held the disk or plate 7 of conducting material. And between the plate or disk 4 and the member 6 are held the various resistance coils A, B, C, D, and E, which may be double wound, that is, non-inductively, upon insulating bushings or cylinders 8 disposed upon metal tubes 9, being held in place between the disk 4 and the disk 6. The disk 4 may have a lug 3 for each tube 9 which receives such lug 3 as indicated in Fig. 2.

Molded in or to the plate 4 are the five metal contact plates, 10, 11, 12, 13, and 14. One of these plates, as 10, is shown in perspective in Fig. 5 as having the downwardly projecting portions 10^a and outwardly extending portions 10^b, these portions 10^a and 10^b being molded within the body of the disk 4, the outer ends of the parts 10^b being then bent laterally as seen in Figs. 1 and 3. The holes or recesses 10^c are provided to allow the insulating material of the disk 4 to extend through these holes to form a more secure anchorage for the contact plate to the disk 4. The other contact plates 11 to 14 inclusive are similarly constructed and embedded and have their terminals 11^b, etc., bent over as in Fig. 3, a hole 11^c, similar to hole 10^c of Fig. 5, being shown in Fig. 3.

The coil A may be of any suitable resistance, for example, 1 ohm, 10 ohms, 100 ohms, etc., according to the range of the resistance set. For convenience the resistance of the coil A will be considered as a unit. The coils B, C, D and E, are preferably all of equal resistance, and preferably all twice the resistance of the coil A, that is, two units. One terminal of the coil A is connected to the metal lug 7' secured to or integral with the plate 7, this lug 7' being bent down at right angles as shown in Figs. 1 to 4 inclusive. The other terminal of the coil A is connected to the lug 15 secured to or preferably integral with the contact plate 16 which has the lug 17 embedded or molded in the disk 4 and forming a connection be-

tween the lug 15 and the plate 16. See Fig. 6. The lug 15 is also embedded in the disk 4 and is then turned laterally parallel to the edge of the disk 4 as indicated in Fig. 1.

5 The plate 16 is preferably more or less embedded in the plate 4, or may be otherwise secured thereto, leaving the outer surface of the plate 16 free for contacting purposes, as is the case with the contact plates 10 to 14 inclusive.

10 One terminal of the coil B is connected to a lug 10^b of the contact plate 10 while its other terminal is connected to one lug 11^b of the contact plate 11; one terminal of the coil C is connected to the remaining lug 11^b of contact plate 11, while its other terminal is connected to one lug 12^b of contact plate 12; one terminal of the coil D is connected to the remaining lug 12^b of plate 12 while its remaining terminal is connected to one lug 13^b of plate 13; and one terminal of the coil E is connected to the remaining lug 13^b of plate 13 while its other terminal is connected to one lug 14^b of the contact plate 14.

20 The remaining lug 14^b of the plate 14 forms one terminal of the instrument which may be connected by conductor 18 to a suitable binding post terminal of the instrument. The other terminal of the instrument is the lug 15 which may be connected by conductor 19 with a binding post terminal of the instrument.

A head or handle 20 is secured to the shaft 21 which extends through the base 1, boss 5 and disk 4, and in so doing passing through the hole 7^a in disk 7 and the hole 16^a in the plate 16, the hole 16^a being suitably larger than the shaft 21 to prevent electrical contact between plate 16 and the shaft 21.

40 Below the shoulder 21^a of the shaft 21 is a metallic collar 22 sweated, soldered, brazed, or otherwise electrically connected to the shaft 21, the lower face of the collar 22 maintaining a firm rubbing contact with the plate 7. The firmness or perfection of this rubbing contact is further insured by the spring contact 23 formed of a plurality of laminae of resilient conducting material such as phosphor bronze, the ends of the laminae being turned at right angles as indicated at 24 and 25 for engaging with cooperating contacts. This structure forms a relatively stiff spring which draws the collar 22 snugly against the plate 7. The brush contact 23 is secured upon the lower angular or non-circular end 21^b of the shaft 21, the laminae of the brush 23 having perforations which fit the part 21^b so as to be rotated thereby, as hereafter described. A pin 21^c passes through the end 21^b and retains the brush 23 in place. At approximately the center of the brush 23 it has downwardly extending laminae lugs 23^a which are soldered to the conducting plate 23^b which is in turn soldered to the lower end of the part 21^b of the

shaft 21, whereby all the laminae of the brush 23 are in permanent and perfect electrical communication with the shaft 21 and through the collar 22 with the plate 7 and therefore with the lug 7' and one terminal 70 of the coil A.

The ends of the laminae of brush 23 are adapted to engage and traverse the metallic contact plates 10 to 14 inclusive. The ends 25 of the laminae of brush 23 do not extend out so far from the shaft 21 and never engage these contact plates 10 to 14 inclusive, but engage in succession, as the shaft 21 is rotated by handle 20, the projections or raised portions 26 of insulating material integral with the disk 4, and the outwardly extending conducting projections 27, 28, 29, 30 and 31 integral with the plate 16, these projections 27 to 31 inclusive lying between the projections 26. It is preferred that the insulating material be cut away or depressed between the projections 26 and the neighboring contact members 27 to 31 inclusive, as indicated at 32, so that as the ends 25 of the brush 23 pass over the contacts 27 to 31 inclusive and the raised insulating portions 26 no conducting path, even of high resistance, can be improperly formed, as might be the case by the wearing away of the material of the ends 25 upon insulating material after considerable use.

Movable with the handle 20 and shaft 21 may be a dial plate 32^a which may have 10 equally spaced perforations or depressions 33 in which may engage a ball or other detent 34, pressed by spring 35, the ball and spring being located in a hole 36 in the base 1. The depressions or perforations 33 are so located that the 10 different positions of the brush 23 may be determined. The dial plate 32^a may carry on its upper surface figures or characters, one at each position, designating the resistance in circuit for each position, a suitable stationary indicating member 37 being provided to aid in the reading; that is, whatever figure or character is adjacent to the stationary pointer 37 indicates the amount of resistance in the circuit.

The operation is as follows: It being remembered that one terminal of the unit coil A is connected to the clip or tongue 7', it is evident that one terminal of the coil A is permanently in electrical communication with the brush contact 23 through plate 7, collar 22 and shaft 21; and it being remembered that one terminal of the instrument is in effect the plate 16 and therefore any of the contacts 27 to 31 inclusive, while the remaining terminal of the instrument is in effect contact plate 14, if the brush 23 is rotated to such position that the end 24 of the brush is in engagement with the contact plate 14 while the end 25 is engaging contact 29 of the plate 16, there is no resistance in circuit because, as will be seen from Fig. 130

3, current will enter, for example by conductor 19, pass through lug 15, plate 16, contact 29, brush 23, to plate 14, lug 14^b, and thence by conductor 18. If now the
 5 brush 23 be rotated in a counter-clockwise direction, as viewed in Fig. 3, a tenth of a revolution, from the position above assumed, contact 24 of brush 23 will still be in engagement with contact 14 but the end 25 will be
 10 upon that insulating surface 26 located between contact 29 and contact 28. In such case current entering by conductor 19, for example, cannot pass to brush 23 because the end 25 is on insulating material 26. It will
 15 therefore be compelled to pass through coil A to the tongue 7 to the brush 23 to plate 14 and to conductor 18, thus including only the coil A in circuit. A further tenth of a revolution in counter-clockwise direction on
 20 the part of brush 23 will bring the brush 23 to the position illustrated in Fig. 3 in which case current entering through conductor 19 will pass through plate 16, contact 28, contact 25, brush 23, contact 24, to contact plate
 25 13 thence through coil E to plate 14 and thence by conductor 18, thus including only the coil E in circuit. A further tenth of a revolution in the same direction will bring
 30 contact 25 onto that insulating section 26 lying between contacts 28 and 27, contact 24 being still in engagement with plate 13. In this case current entering by conductor 19 is again compelled to traverse coil A and
 35 thence through the shaft 21 and brush 23 to plate 13 thence through coil E to plate 14 and thence by conductor 18, thus including both coils A and E in circuit in series with each other. A further tenth of a revolution
 40 of the brush 23 carries its contact 25 onto contact 27 and its contact 24 onto plate 12 in which case current entering by conductor 19 passes through plate 16, contact 27, brush 23 to plate 12 thence through coil D
 45 to plate 13, thence through coil E to plate 14 and thence by conductor 18, thus including in circuit only coils E and D in series with each other, coil A being out of circuit. And so on for each tenth of a revolution,
 50 the coil A is alternately cut into and cut out of circuit, being cut into circuit in the position after that in which one of the coils B, C, D, or E is brought into circuit, and being cut out of circuit at each position in which
 55 a new coil B, C, D or E is brought into circuit. From this operation it will be seen that first a coil of unit resistance is brought into circuit, then it is cut out of circuit and a coil of double unit resistance is brought into
 60 circuit; then the coil of double unit resistance is left in circuit and the coil of unit resistance is added to the circuit, and so on. And it is apparent that by this arrangement with only five coils ten different amounts of
 65 resistance may be brought into circuit varying from zero resistance to nine units.

Whenever the contact 25 of brush 23 is on any of the contacts 27 to 31 inclusive the unit coil A is cut out of circuit; and whenever the contact 25 is on an insulating surface 26 coil A is cut into circuit. It will be noted further that the structure disclosed is such as to
 70 dispense with and avoid the errors due to connecting or cross-connecting wires within the instrument, since the terminals of the coils are soldered directly to near metallic parts,
 75 thus requiring no connectors. And it will be observed that between the terminals 18 and 19 of the instrument the number of rubbing or sliding contacts is constant, namely two; part of the time these two rubbing or
 80 sliding contacts are at the contacts 24 and 25 of the brush 23, and in the other positions at contact 24 of brush 23 and at the contact between the collar 22 and plate 7. And accordingly any error in resistance
 85 arises from variations of these contact resistances rather than from their actual value. But by the construction shown the value of these contact resistances is substantially negligible and the variations of
 90 these contact resistances are a minimum. Obviously the movable contact member 23 may be stationary and the contacts 10 to 15 inclusive and the contacts 27 to 31 inclusive
 95 may be movable.

My invention may also take the form illustrated in Fig. 7 which illustrates a
 100 "plug set," the example illustrated being for a decade set of four rows, that is, units, tens, hundreds, and thousands of ohms. Upon the box cover or base 40 of hard rubber or other suitable insulating material is provided, for the unit row, five conducting
 105 blocks 41, 42, 43, 44 and 45 disposed between two conducting bars 46 and 47. Into the holes as 48, two such holes being provided between each block and the bars, may be inserted a metallic plug P to form electrical communication between the block and
 110 bar. A unit resistance 49, for example 1 ohm, has its terminals connected to the bars 46 and 47. The block 41 may be considered one terminal of the instrument or of the unit row while the other terminal of the
 115 row is bar 47, conductor 50 extending from the block 41 to the binding post or external circuit while conductor 51 connects one terminal of the resistance 49 with the block 47 and may lead to a binding post or the
 120 external circuit for cases where the first row only is used. A second resistance 52, for example of two units of resistance, has one terminal connected to block 41 and its other terminal to the block 42; a third resistance 53, for example equal to resistance
 125 52, has one terminal connected to the block 42 and its other terminal connected to the block 43; a fourth resistance 54, for example equal to resistance 52, has one terminal connected to block 43 and its other
 130

terminal to the block 44; and a fifth resistance, for example equal to resistance 52, has its one terminal connected to block 44 and its other terminal to the block 45. Assuming this a unit row, resistance 49 may be one ohm, while each of resistances 52 to 55 is two ohms. It will accordingly be seen that by inserting the plug P between block 41 and bar 47 there will be no resistance in circuit. By transferring the plug P to connect bar 41 with bar 46, current will enter for example through conductor 50 pass through block 41, plug P, bar 46, through resistance 49 to conductor 51, thus inserting in circuit one ohm. If now the plug be inserted between block 42 and bar 47 only coil 52 will be in circuit, therefore introducing two ohms. By transferring the plug to connect block 42 with bar 46 both resistances 49 and 52 will be in circuit in series with each other, thus introducing three ohms. And so on by inserting the plug P in the different holes any amount of resistance from zero to nine ohms may be brought into circuit, by one ohm steps, in alternate positions unit resistance 49 being excluded from the circuit. And for the second row a unit resistance 56, of for example ten ohms, has one terminal connected to the bar 57. And between the neighboring blocks 58 to 62 inclusive are connected double unit coils 63 to 66 inclusive of say 20 ohms each. And for the third row a unit resistance 67, of say 100 ohms, has its one terminal connected to the bar 68 and its other terminal to the bar 69. And the blocks 70 to 74 inclusive have connected between them the resistance coils 75 to 78 inclusive each of 200 ohms, for example. The blocks 58 and 70 are electrically connected with each other by conductor 79. And for the fourth row a unit resistance 80, of 1000 ohms, for example, has one terminal connected to the bar 69 and its other terminal to the bar 81. And the blocks 82 to 86 inclusive have connected between them the resistance coils 87 to 90 inclusive each of 2000 ohms resistance, for example. And to the block 82 is connected the circuit conductor 91.

From the description of the first or unit row it will be apparent that by inserting a plug in the proper hole of each row, any resistance, from zero, varying by steps of one ohm, may be brought into circuit, a maximum resistance with the values assumed, being 9999 ohms. And as to the second, third and fourth rows, the same is true as of the first row, namely that ten different resistance values, from zero to nine units, in each row, may be obtained with only five coils.

It will be understood that in place of resistances herein described, may be used any other electrical units or quantities, as,

for example, sources of current or electromotive-force, capacities or condensers, or inductances.

What I claim is:

1. The combination with a plurality of resistances, stationary contacts between which some of said resistances are connected, opposing contacts, and a movable contact permanently connected to another of said resistances, movement of said movable contact with respect to said stationary contacts bringing into circuit one after another of said first named resistances, and in positions between introduction of successive of said first named resistances bringing into circuit said last named resistance.

2. The combination with a row of separated contacts, of resistances connected to said contacts, opposite to each of said contacts a contact and an insulator, a movable contact member adapted to traverse said contacts and insulators in succession, and a resistance associated with said movable contact member and brought thereby into circuit when engaging only one of said first named contacts and taken out of circuit when simultaneously engaging one of said first named contacts and an opposed contact.

3. The combination with a series of contacts, resistances connected thereto, opposed separated contacts connected to each other, a movable contact adapted to bridge opposing contacts, a resistance having one terminal connected to said movable contact and its other terminal connected to said inter-connected opposing contacts, said movable contact member maintaining contact with each of said first named contacts when in position intermediate neighboring of said opposing contacts.

4. The combination with a block of insulating material, of a contact having a contact surface external to said material, a projection thereon molded in said insulating material and projecting outside of said insulating material to form an external terminal.

5. The combination with a block of insulating material, of a contact, a projection thereon molded in said insulating material and projecting from said insulating material to form a terminal, said projection having an aperture into which said insulating material extends.

6. The combination with a block of insulating material, of a contact plate thereon, a projection on said contact plate molded in said material, and a lug on said projection molded in said material and projecting therefrom to form a terminal for said plate.

7. In a resistance set, a single unit resistance, a series of double unit resistances, a series of contacts between which said double unit resistances are connected, an opposing series of inter-connected contacts, and a

movable contact connected to said single unit resistance, said movable contact having two positions for each of said first named contacts, in one of said positions said first named resistance included in circuit and in the other of said positions excluded from circuit.

8. The combination with a rotatable contact member, of a plurality of resistance coils disposed around the axis of rotation of said contact member, a plate of insulating material, a plurality of contacts having parts molded therein and projecting therefrom, terminals of said resistance coils connected directly to said projecting parts of said contacts, another contact disposed about the axis of rotation of said rotatable contact member, said rotatable contact making and breaking circuit with said last named contact in traversing each of said plurality of contacts

9. The combination with a plurality of resistances, of relatively movable contacts, connections whereby for all positions of said relatively movable contacts the number of contact resistances in circuit is constant, and connections whereby relative movement of said contacts in every alternate position cuts out of circuit one of said resistances and in the remaining positions bringing said resistance into circuit alone or with one or more of the remainder of said resistances.

10. The combination with a plurality of resistances, of relatively movable contacts, connections whereby for all positions of said relatively movable contacts the number of contact resistances in circuit is constant, and connections whereby relative movement of said contacts in every alternate position short circuits one of said resistances and in the remaining position bringing said resistance into circuit alone or with one or more of the remainder of said resistances.

11. The combination with a plurality of resistances, of relatively movable contacts, connections whereby for all positions of said relatively movable contacts the number of contact resistances in circuit is constant, said relatively movable contacts comprising two series of contacts and a movable contact, said movable contact in two neighboring positions connecting contacts of the two series together and engaging the same contact of the one series alone.

12. The combination with a plurality of resistances, of relatively movable contacts, connections whereby for all positions of said relatively movable contacts the number of contact resistances in circuit is constant, said relatively movable contacts comprising two series of contacts and a movable contact, said movable contact in two neighboring posi-

tions connecting contacts of the two series together and engaging the same contact of the one series alone, and connections whereby in each alternate position of said movable contact one of said resistances is cut out of circuit and in every other position said resistance is brought into circuit alone or with one or more of the remainder of said resistances.

13. The combination with a plurality of resistances, of relatively movable contacts, said relatively movable contacts comprising two series of contacts and a movable contact, the contacts of one of said series interconnected with each other through connections of negligible resistance, said movable contact in two neighboring positions connecting contacts of the two series together and engaging the same contact of the one series alone.

14. The combination with a plurality of resistances, of relatively movable contacts, said relatively movable contacts comprising two series of contacts and a movable contact, said movable contact in two neighboring positions connecting contacts of the two series together and engaging the same contact of the one series alone, and connections whereby in each alternate position of said movable contact one of said resistances is cut out of circuit and in every other position said resistance is brought into circuit alone or with one or more of the remainder of said resistances.

15. The combination with a series of contacts, of a plurality of resistances connected between said contacts, a conducting member having a plurality of contacts, and a movable contact member which in neighboring positions connects a contact of said series with a contact of said conducting member and connects with the same contact of said series alone.

16. The combination with a series of contacts, of a plurality of resistances connected between said contacts, a conducting member having a plurality of contacts, a movable contact member which in neighboring positions connects a contact of said series with a contact of said conducting member and connects with the same contact of said series alone, and a resistance whose terminals are connected respectively to said movable contact and to said conducting member.

In testimony whereof I have hereunto affixed my signature in the presence of two subscribing witnesses.

IRVING B. SMITH.

Witnesses:

NELLIE EVANS,
ALICE S. MARSH.