(No Model.)

R. M. HUNTER.

ELECTRIC ARC LAMP.

No. 493,359. Patented Mar. 14, 1893.

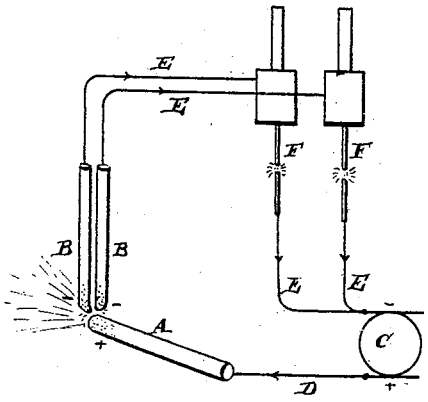


FIG. 1

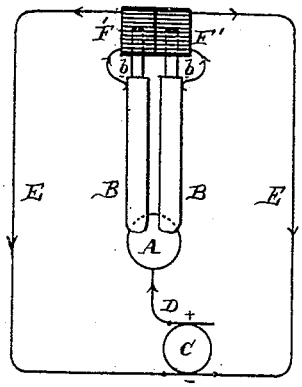
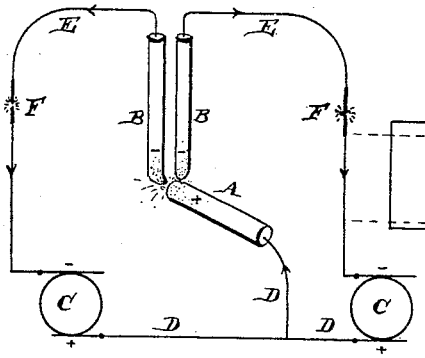


FIG. 2

FIG. 3



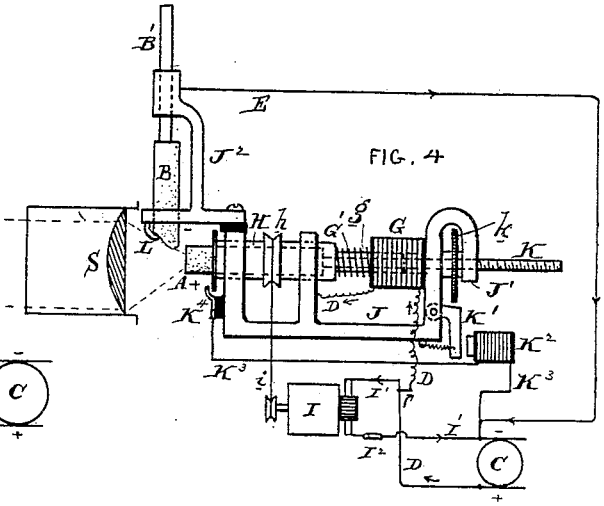


FIG. 4

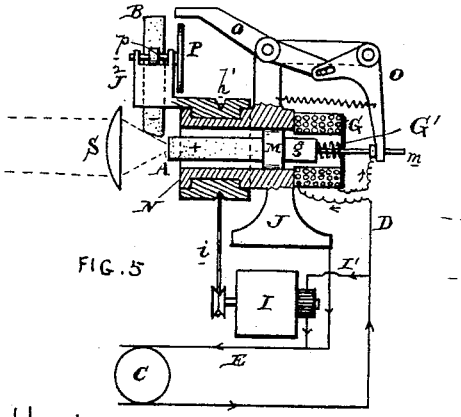


FIG. 5

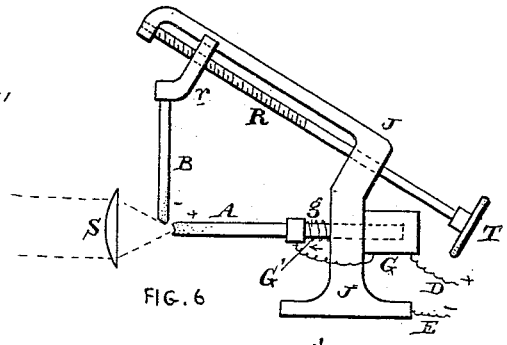


FIG. 6

Attest.
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S. T. Yerkes.

Inventor
R. M. Hunter

UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 493,359, dated March 14, 1893.

Application filed September 1, 1892. Serial No. 444,723. (No model.)

To all whom it may concern:

Be it known that I, RUDOLPH M. HUNTER, of the city and county of Philadelphia and State of Pennsylvania, have invented an Improvement in Electric Lamps, of which the following is a specification.

My invention has reference to electric lamps and consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings which form a part thereof.

This application, Case No. 225, has special reference to the construction of lamps of the general nature set out in Letters Patent No. 478,510, granted to me on July 5, 1892.

The object is to produce, as far as possible, a large crater upon the end of the horizontal or reflecting carbon, so as to insure as direct and intense a light as possible. In the lamp illustrated in the said patent, there is employed one horizontal and one vertical carbon, and as a natural result the crater on the horizontal carbon forms somewhat near the upper part. By employing more than one vertical carbon or carbons at right angles to the horizontal carbon, the crater may be enlarged, and by employing a number of these additional carbons they may be made to act upon the horizontal carbon throughout its entire circumference and thus fully distribute the current. The objection, however, to this is that there are a number of arcs to be maintained which somewhat complicates the structure. However, in carrying out this part of my invention, I connect the positive terminal of the generator with the horizontal or positive carbon, and connect the negative terminal of the generator by separate circuits with the two or more carbons arranged at an angle to the horizontal carbon, and in these independent circuits I prefer to provide independent regulators so as to properly subdivide the current and insure it flowing between the several carbons. These regulators may be of any suitable kind as will be more fully described later on. If desired, the regulator feature may be formed in the generator or source of supply itself by employing a separate generator for each of the negative carbons, or providing a single generator with two or more armatures, which are respectively connected with the two or more negative carbons.

To obviate the necessity of employing a large number of negative carbons and at the same time to produce a perfect crater or luminous end to the horizontal carbon, I may either rotate the horizontal carbon, or rotate the vertical carbons about the axis of the horizontal carbon. By this means the current is caused to react upon all parts of the end of the horizontal carbon to an equal extent, and the luminosity is uniform and steady about the end of the said horizontal carbon. This enables the point of greatest luminosity to be extended over a larger area than that set out in my patent aforesaid and produces a more uniform light upon the condensing lense used in connection therewith.

I do not confine myself to any special form of apparatus so far as the details of construction are concerned as this application is intended to set out the general principles of construction involved in said improvements. The details may be greatly varied to suit any particular design of lamp without in the least departing from the principles of the invention.

Referring to the drawings: Figure 1 is a diagram illustrating the employment of two negative carbons and one positive carbon while embodying my improvement. Fig. 2 is a similar view showing the negative and positive carbons in elevation and looking end on with respect to the horizontal or positive carbon. Fig. 3 is a similar view to Fig. 1 showing a modification of the structure therein illustrated. Fig. 4 is a side elevation of an electric lamp having a revolving positive carbon and the necessary regulating mechanism for maintaining uniform arc. Fig. 5 is a sectional elevation of a modification of the structure shown in Fig. 4, but in which the negative carbon is caused to revolve about the positive carbon; and Fig. 6 illustrates a general construction of the lamp wherein the negative carbon is fed obliquely with respect to the horizontal carbon.

Referring to Fig. 1, A is the positive carbon, and is employed by me as the horizontal

carbon, though in the construction of search lights, this carbon often assumes various angles corresponding to the direction in which the beam of light is projected. For simplicity, however, it may be called the horizontal carbon. B B are two vertical negative carbons. These carbons are arranged at right angles to the carbon A. It is evident, however, that they need not be arranged exactly at right angles, as any suitable angle might be employed according to the particular design of the lamp. C is the generator or source of electric energy such as the dynamo electric machine. D is the conductor connecting the positive terminal of the generator C with the positive carbon A. E E are two circuits leading from the negative terminal of the generator C and respectively connecting with the negative carbons B B. F F are two regulators, shown as two arc lamps, and are respectively arranged in the circuits E E. The current passes from the generator through the carbons B B, circuits E E, and lamps F F. If the resistance between the carbon A and either one of the carbons B B was greater than that between the carbon A and the other carbon B, the lamp F corresponding to the said first mentioned carbon B would decrease its resistance automatically so as to maintain the resistance to the circuit from A through each of the carbons B B substantially the same under all conditions. The lamps F F act as regulators so that the carbons B B may be held in a rigid support so far as any relative movements between them is concerned. The lamps F F increase or decrease their arcs inversely with the change of resistance between the carbon A and the carbons B B. By this means the arc formed between the carbons A and B remains uniform and more fully distributed than in the case where simply one carbon B is employed. It is evident that the carbons B B may be set at different angles, and more than two may be employed, if so desired.

Referring to Fig. 2, we have the same construction as illustrated in Fig. 1 except that in place of employing lamps F F as regulators, regulators F′ are made to act directly upon the carbons B B to move them relatively with respect to the carbons A to vary the resistance. The carbons B B are fitted with cores *b* which work in the solenoids F′ in the respective circuits E E. If the resistance becomes too great between one of the carbons B and the carbon A, the solenoid F′ thereof is weakened and the carbon B is lowered to reduce the resistance and maintain the arc. In this case, the regulators act directly upon the carbons B B, but the general principle of regulation, consisting in varying the resistance in the independent return circuits to the negative terminal of the generator, is the same.

Referring to Fig. 3, we have the same general arrangement as in Figs. 1 and 2, except that in this case two generators C C are employed in which their positive terminals are connected with the positive carbon A, and their negative terminals are respectively connected with the negative carbons B B. By this means the current is forced to maintain arcs between the carbon A and the respective carbons B B irrespective of any slight variation in the resistance of the arcs. It is true that one of the arcs might be more brilliant than the other under some conditions at times, but the double arc is maintained under all working of the apparatus. It is quite evident that in place of the use of the separate generators C C the source of supply may be a single generator having two independent armatures revolving in the same field, which form of generator is well known. More than two carbons B B may be employed if so desired, but in this case additional generators or armatures would be required. The regulators F F may be used in the return circuits E E as in the case of Figs. 1 and 2. In these various constructions the carbons may be supported in suitable frames such as illustrated in Fig. 6. Referring to this figure, J is the frame of the lamp and has an oblique guide for the carbon holder *r* carrying the negative carbon B. An oblique screw R having a handle T may be employed for guiding and moving the carriage *r* so as to make the carbon B move transversely to the length of the positive carbon A. The positive carbon is held in the core *g* which is guided in a solenoid G in the circuit D. The spring G′ opposes the action of the solenoid so as to move the carbon A toward the carbon B whenever the current in the solenoid G becomes weakened by the formation of too great an arc, or vice versa. E is the return circuit. In the construction shown in Fig. 2, the weight of the carbons B B may of itself be sufficient to oppose the action of the solenoids F F′. S indicates a condenser lens for receiving the rotating rays of light from the end of the carbon A and bending them into the requisite direction so as to properly project them upon the object to be illuminated.

Referring to Fig. 4, we have the positive carbon A supported in a revolving holder H carried in the stationary frame J. The revolving holder H is provided with a grooved wheel *h* by which it is revolved through the agency of a band *i* and electric motor I. The holder H is provided with a core *g* which enters the stationary solenoid G. The solenoid tends to pull the holder backward through its action upon the core, and a spring G′ tends to throw the holder forward in opposition to the action of the solenoid when it becomes weakened. Arranged within the holder and its core and adapted to revolve with them is a screw threaded rod K. *k* is a nut carried between the main frame J and an extension J′ and is loosely supported upon the screw threaded rod K. As the holder H revolves, the carbon A and the rod K and nut *k* revolve

with it. B is the negative carbon and is carried by a guide B′ in an insulated portion J^2 of the main frame. The finger L prevents the carbon B falling too low. As the carbon is consumed, its own weight feeds it downward. As the carbon A revolves, the current passes from the generator C by circuit D, through solenoid G, frame J, holder H, carbon A to carbon B and back by circuit E to source of supply C. The rapidly rotating carbon A causes the end of the carbon to become luminous throughout its entire circumference and have all the effect of employing an infinite number of small arcs arranged about its circumference. Furthermore, by this construction the place of great luminosity is evenly located upon the end of the carbon A. The rays of light are passed through a condensing lens S and projected upon the object. As the carbons become consumed, the holder will be permitted to move to the left under the action of the spring G′. This will also move the feed wheel *k* and the screw threaded rod K equally to the left. When this movement has reached its maximum, the switch K^4 is closed, and a magnet K^2 in a shunt circuit K^3 is energized and draws up the armature K′. The armature K′ arrests the rotation of the feed wheel K and positively feeds the screw threaded rod K to the left pushing the carbon farther out of the holder H in which it is held. As soon as the arc decreases in resistance, the holder H is drawn back by the action of the solenoid G, the switch K^4 is opened, the armature K′ drops back and the feed wheel again revolves freely with the holder and the screw threaded rod K. The rays of light from the arc are passed through the condenser lens S and thus directed upon the object to be illuminated. The motor I, for operating the holder H, is in a motor circuit I′ and may be put in or out of operation by the switch I^2. As the carbon A rotates, all parts of its end are directed alike to the action of the current, and in practice I have found that the end of the carbon is as cleanly cut as if it were placed in a lathe and turned up. It is absolutely uniform, and consequently the rays of light emanate from all parts alike.

Referring to Fig. 5, we have the positive carbon held in the holder M terminating in the core *g* of the solenoid G as before. This carbon A is fed through the frame J either by the action of the solenoid upon the core *g* or by the action of the spring G′ opposing the solenoid. The negative carbon B is held in a frame J^2 journaled at N upon the main frame J. The frame J^2 is provided with a groove *h*′ in which a band *i* runs, so as to rotate the said frame by an electric motor I. The negative carbon B is carried by a friction wheel *p* secured to a shaft integral with the feed wheel P. C is the source of electric energy, and D is the positive circuit leading to the solenoid G and thence to the carbon A. The guide M is of insulating material so as to insulate the carbon A from the frame J. E is the return circuit. I′ is the motor circuit coupled in parallel with the electric lamp. O O are two levers hinged together, one of which acts upon the small rod *m* extending rearwardly from the core *g*, and the other of which is adapted to intermittently act upon the feed wheel P. As the frame J^2 is rotated about the frame J, the negative carbon is revolved about the axis of the positive carbon A, causing the arc to rapidly travel about the end of said carbon A and producing an intensely luminous end. By revolving the negative carbon very rapidly, it is evident that this luminosity may be uniform throughout the entire end of the positive carbon. The rays of light radiating from the intensely heated carbon pass through the condenser lens S and are projected upon the object. The solenoid G maintains the arc between the carbons by drawing the carbon A backward. As the carbons become consumed, the solenoid becomes weaker as the arc increases in resistance and the carbon A is moved to the left, and simultaneously therewith the levers O are brought down into position so that the friction wheel P in passing strikes the end of said levers, and feeds the carbon B toward the carbon A. As the carbon B approaches the carbon A, the resistance of the arc becomes less and the solenoid G becomes stronger. This instantly draws back the carbon A and at the same time removes the action of the levers O. It is immaterial, so far as my invention is concerned, what form of regulating apparatus is employed, as the essential feature is the relative movement of the carbons, whereby the positive carbon may be equally heated throughout its end.

In practice I have found that the rotation of the horizontal or positive carbon, while maintaining the negative carbons in relatively fixed positions, is preferable to the case in which the negative carbon revolves about the end of the positive carbon, in view of the fact that the centrifugal action in the latter case is somewhat objectionable where great rapidity of revolution is required. Proper mechanical construction, however, may greatly remedy this defect, as the holder for the circular carbons may be a circular disk, through radial holes in which a series of negative carbons may pass.

It is evident that any number of negative carbons B may be employed with the apparatus shown in Figs. 4, 5, and 6.

The minor details of construction may be greatly modified without departing from the principles of my invention, and therefore I do not limit myself to the mere details here shown.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an arc lamp, the combination of a positive carbon and two or more negative carbons

arranged to form arcs between the said positive carbon and negative carbons, a source of electric energy, a connecting circuit between the positive terminal of the source of electric energy and the positive carbon, and separate circuits for carrying independently maintained electric currents between the negative terminal or terminals of the source of electric energy and the negative carbons.

2. In an arc lamp, the combination of a positive carbon and two or more negative carbons arranged to form arcs between the said positive carbon and negative carbons, a source of electric energy, a connecting circuit between the positive terminal of the source of electric energy and the positive carbon, independent circuits between the negative terminal or terminals of the source of electric energy and the negative carbons, and independent regulators in the circuits connecting with the negative carbons for controlling the arcs between the negative carbons and the positive carbon.

3. In an arc lamp, the combination of a positive carbon and two or more negative carbons arranged to form arcs between the said positive carbon and negative carbons, a source of electric energy, a connecting circuit between the positive terminal of the source of electric energy and the positive carbon, independent circuits between the negative terminal or terminals of the source of electric energy and the negative carbons, and independent regulators in the circuits connecting with the negative carbons for controlling the arcs between the negative carbons and positive carbon consisting of automatic devices influenced by the current flowing in the circuits for regulating the resistance of the several independent circuits.

4. In an arc lamp, the combination of a positive carbon and two or more negative carbons arranged to form arcs between the said positive carbon and negative carbons, a source of electric energy, a connecting circuit between the positive terminal of the source of electric energy and the positive carbon, independent circuits between the negative terminal or terminals of the source of electric energy and the negative carbons, and independent regulators for controlling the arcs between the negative carbons and the positive carbon consisting of arc lamps for changing the resistance in the circuits inversely with the resistance of the arcs between the positive and negative carbons.

5. In an electric lamp, the combination of a positive carbon and two or more negative carbons, two separate generating armatures or sources of electric energy, connecting circuits between the positive terminals of the armatures and the positive carbon, and independent circuits between the negative terminals of the armatures and the respective negative carbons.

6. In an electric lamp, the combination of a positive carbon and two or more negative carbons, two separate generating armatures or sources of electric energy, connecting circuits between the positive terminals of the armatures and the positive carbon, independent circuits between the negative terminals of the armatures and the respective negative carbons, and independent regulators in the circuits connecting with the negative carbons for controlling the arcs between the negative carbons and the positive carbon.

7. In an electric lamp, the combination of a positive carbon and two or more negative carbons, two separate generating armatures or sources of electric energy, connecting circuits between the positive terminals of the armatures and the positive carbon, independent circuits between the negative terminals of the armatures and the respective negative carbons, and independent regulators in the circuits connecting with the negative carbons for controlling the arcs between the negative carbons and the positive carbon consisting of automatic devices influenced by the current flowing in the circuits for regulating the resistance of the several independent circuits.

8. An arc lamp having one carbon of one polarity and two or more carbons of different polarity for the purpose of maintaining two or more independent arcs, and in which the carbons of one polarity are arranged at substantially right angles to the carbons of the other polarity, and separate circuits for carrying independent maintained electric currents for the two or more carbons.

9. An arc lamp having two or more carbons of one polarity and a carbon of different polarity for the purpose of maintaining two or more independent arcs, and in which the carbons of one polarity are arranged at substantially right angles to the carbons of the other polarity, in combination with means to feed the carbons of one polarity obliquely with respect to the length of the carbon of the other polarity, and independent electrical circuits including the two or more carbons of one polarity whereby separate currents are fed to the said several carbons.

10. An arc lamp having two or more carbons of one polarity and a carbon of different polarity for the purpose of maintaining two or more independent arcs, and in which the carbons of one polarity are arranged at substantially right angles to the carbons of the other polarity, in combination with means to feed the carbons of one polarity obliquely with respect to the length of the carbon of the other polarity, independent electrical circuits including the two or more carbons of one polarity whereby separate currents are fed to the said several carbons, and an automatic regulator for varying the relative positions of the carbons to maintain arcs of substantially uniform brilliancy.

11. In an electric lamp, the combination of two cylindrical carbons arranged at an angle to each other, a source of electric energy in

circuit with the said carbons, and means to cause a very rapid continuous and uniform relative movement between the said carbons to bring all portions of the end of one of the carbons repeatedly and frequently within the zone of the arc whereby the arc formed between the carbons is caused to travel with great rapidity about the end of one of the carbons and maintains the entire end of the carbon at a high temperature.

12. In an electric lamp, the combination of two carbons arranged at an angle to each other, a source of electric energy in circuit with the said carbons, and means to cause a relative movement between the said carbons, whereby the arc formed between them is caused to rapidly travel about the end of one of the carbons, and an electric regulator for moving one of the carbons to maintain an arc of uniform brilliancy.

13. In an electric lamp, the combination of two carbons arranged at an angle to each other, a source of electric energy in circuit with the said carbons, and means to cause a relative movement between the said carbons whereby the arc formed between them is caused to rapidly travel about the end of one of the carbons, an electric regulator for moving one of the carbons to maintain an arc of uniform brilliancy, and means to feed the carbons relatively together to compensate for the consumption thereof.

14. In an electric lamp, the combination of two carbons arranged at an angle to each other, a source of electric energy in circuit with the said carbons, means to cause a relative movement between the said carbons whereby the arc formed between them is caused to rapidly travel about the end of one of the carbons, an electric regulator for moving one of the carbons to maintain an arc of uniform brilliancy, and means to feed the carbons relatively together to compensate for the consumption thereof, and an electric controlling device controlled by the movement of the carbon holder to operate said feeding device.

15. In an electric lamp, the combination of two carbons arranged at an angle to each other, suitable supports for said carbons, power devices to rapidly uniformly and continuously rotate one of said carbons independently of the other whereby the arc is caused to travel about the end of one of the carbons with great rapidity and uniformity, and a source of electric energy including both carbons.

16. In an electric lamp, the combination of two carbons arranged at an angle to each other, suitable supports for said carbons, power devices to operate one of said carbons independently of the other whereby the arc is caused to travel about the end of one of the carbons, and an electric regulator for moving one of the carbons in the direction of its length for maintaining the brilliancy of the arc.

17. In an electric lamp, the combination of the frame, a holder journaled in said frame and adapted to be rotated therein, power devices to rapidly uniformly and continuously rotate the said holder, a carbon carried by said holder, a second carbon arranged at an angle to the first mentioned carbon, a support for the second mentioned carbon, and an electric circuit including both carbons.

18. In an electric lamp, the combination of the frame, a holder journaled in said frame and adapted to be rotated therein, power devices to rotate said holder, a carbon carried by said holder, a second carbon arranged at an angle to the first mentioned carbon, a support for the second mentioned carbon, and an electric regulator to move the holder for maintaining the brilliancy of the arc.

19. In an electric lamp, the combination of two carbons arranged at an angle to each other, a circuit including the said carbons with a source of electric energy, a support for holding one of the carbons, and means for rapidly continuously and uniformly rotating the other carbon, whereby the arc continually travels about the end of one of the carbons.

20. In an electric lamp, the combination of two carbons arranged at an angle to each other, a circuit including the said carbons with a source of electric energy, a support for one of the carbons, and means for rapidly continuously and uniformly rotating the other carbon upon its axis, whereby the arc continually travels about the end of one of the carbons.

21. In an electric lamp, the combination of two carbons arranged at an angle to each other, a circuit including the said carbons with a source of electric energy, a support for one of the carbons, means for rotating the other carbon upon its axis, and an electric regulator for moving the said rotating carbon in the direction of its axis for maintaining the brilliancy of its arc.

22. In an electric lamp, the combination of two carbons arranged at an angle to each other, a circuit including the said carbons with a source of electric energy, a support for one of the carbons, means for rotating the other carbon upon its axis, an electric regulator for moving the said rotating carbon in the direction of its axis for maintaining the brilliancy of its arc, and independent feeding mechanism for feeding the carbon toward the other carbon to compensate for the consumption thereof.

23. In an electric lamp, the combination of two carbons arranged at an angle to each other, a holder for one of the carbons, means to feed it longitudinally or in the direction of its length, and means for rotating the said carbon about its axis.

24. An arc lamp having a carbon of one polarity and two or more carbons of different polarity for the purpose of simultaneously maintaining two or more independent arcs, a

source or sources of electric energy, connecting circuits between the source or sources of electric energy and the several carbons, and independent regulating devices controlled by the current passing through the several arcs for controlling the relative passage of the currents corresponding to the respective arcs.

In testimony of which invention I have hereunto set my hand.

R. M. HUNTER.

Witnesses:
ERNEST HOWARD HUNTER,
CLYDE M. DIETTERICH.