(No Model.) 2 Sheets—Sheet 1.

G. PFANNKUCHE.

ELECTRIC ARC LAMP.

No. 393,447. Patented Nov. 27, 1888.

Fig. 1.

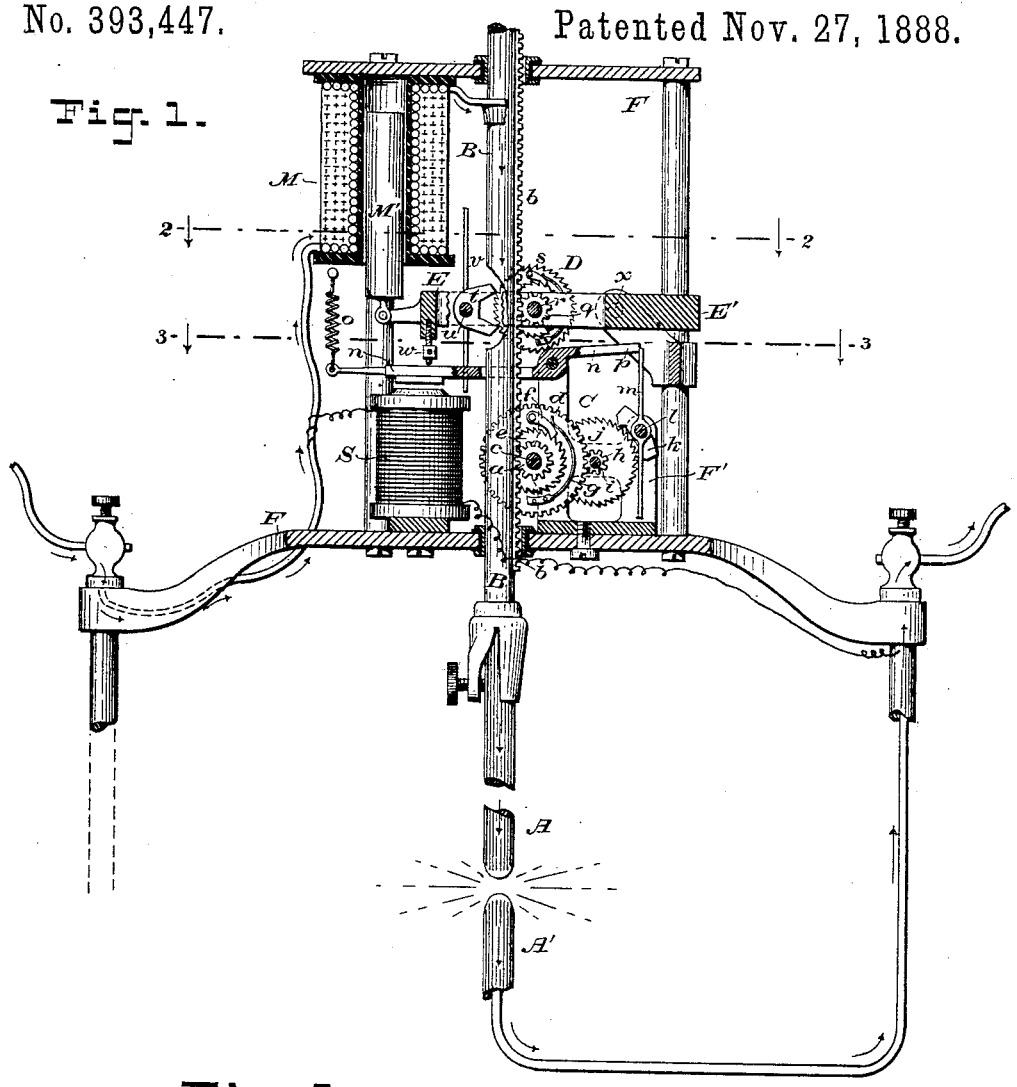


Fig. 2.

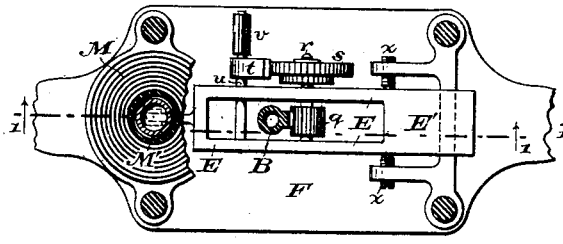
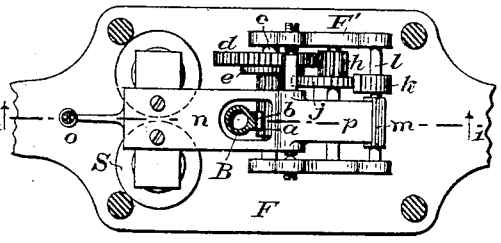


Fig. 3.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

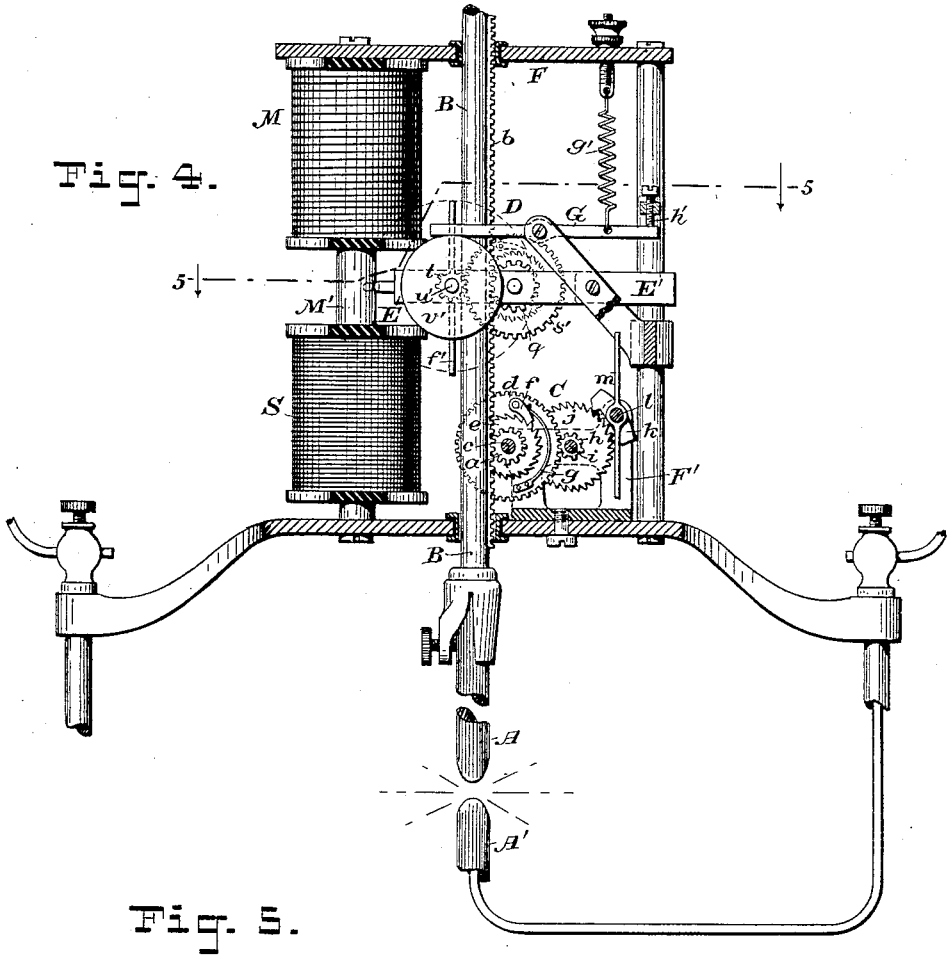
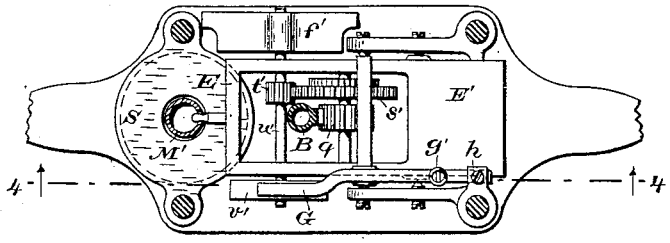


Fig. 5.



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UNITED STATES PATENT OFFICE.

GUSTAV PFANNKUCHE, OF EXETER, NEW HAMPSHIRE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 393,447, dated November 27, 1888.

Application filed September 7, 1886. Serial No. 212,881. (No model.)

To all whom it may concern:

Be it known that I, GUSTAV PFANNKUCHE, a resident of Exeter, in the county of Rockingham and State of New Hampshire, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention relates most particularly to arc lamps of the rack-and-pinion class, or those wherein the carbon-holder is provided with rack-teeth which engage the pinion of a slow-movement gear controlled by electro-magnets for regulating the length of the arc and determining the feed of the carbons as they consume.

In lamps of this character heretofore made the slow-movement gear for retarding the descent of the carbon-holder, as well as the releasing mechanism, has been made bodily movable up and down, being connected to the magnet or solenoid by which the arc is established, so that in the operation of striking the arc the slow-movement gear has been lifted and has been the medium for lifting the carbon-holder. This construction has the disadvantage that the lamp is liable to respond too quickly to sudden or accidental fluctuations in the volume of the current, regardless of the length of the arc. This annoying propensity of such lamps, known as "pumping," accounts for much of the flickering and hissing attendant upon their operation. To overcome this defect some very complicated regulating mechanisms have been invented. The simplest expedient for reducing pumping is the attachment of a "dash-pot" to the frame carrying the gearing; but this overcomes one defect in a measure only by introducing another, since dash-pots are greatly liable to disorder by frost, dust, and other causes.

My invention seeks to overcome the pumping of rack-and-pinion lamps, as well as those of other types, by simple means and without recourse to dash-pots. To this end I have conceived the simple expedient of separating the slow-movement gear for regulating the descent of the carbon-holder from the gearing or mechanism for striking the arc and mounting the slow-movement gear in fixed bearings, so that it has no vertical motion. It thus acts to prevent any sudden descent or pumping downward of the carbon-holder. The pumping upward is resisted by a tension-spring applied to a ratchet and pawl in connection with the slow-movement gear, the resistance being sufficient to prevent the lifting of the carbon-holder by any transitory force or fluctuation of current, but insufficient to prevent its being lifted by the full tension of the main-current magnet for striking the arc, or by the operator for inserting new carbons. Either the slow-movement gear may be the feeding mechanism, or a distinct feeding-gear may be provided. In the former case the shunt-magnet or solenoid will be connected to an arresting device for the slow-movement gear. In the latter case it will be adapted to operate an arresting device for the independent feeding-gear, which gear will thus be mounted in the lifting-frame, which is connected to the main-circuit magnet or solenoid.

The accompanying drawings show my invention embodied in two different constructions.

Figure 1 is an elevation, partly in section, of the essential parts of the lamp; and Figs. 2 and 3 are horizontal sections on the planes of the lines 2 2 and 3 3, respectively. Fig. 4 is an elevation of another construction of lamp, of which Fig. 5 is a horizontal section on the line 5 5 in Fig. 4.

I will first describe the construction shown in Figs. 1, 2, and 3.

Let A designate the upper carbon pencil; A′, the lower one; B, the carbon-holder for carrying the carbon A; C, the "slow-movement gear" as a whole; D, the lifting-gear for striking the arc as a whole; M, the main-circuit magnet or solenoid; S, the shunt-circuit magnet or solenoid, and F the frame-work of the lamp.

The carbon-holder B consists, as usual, of a tubular rod with a cog-rack, *b*, formed on one side, with which meshes the pinion *a* of the slow-movement gear. This pinion is mounted on a small shaft or spindle, *c*, on which is also mounted a toothed wheel or gear, *d*. The pinion *a* communicates with the gear *d* through a ratchet and pawl, so that the carbon-holder cannot descend without turning the gear, but may ascend while the gear remains stationary. In the construction shown

the ratchet-wheel *e* is fixed to or made in one piece with the pinion, while the pawl *f* is pivoted to the gear *d*. The tension-spring *g* of the pawl is also fastened to the wheel *d*, with its free end pressing against the pawl and forcing it toward the ratchet-wheel. This pressure of the spring generates a certain resistance to the backward turning of the ratchet, on account of the obliquity of the ratchet-teeth which lift the pawl. It is desirable that the tension of this spring be made adjustable, in order that the resistance offered by the ratchet to the upward movement of the carbon-holder may be regulated to a nicety. This, however, may be done in the original construction of the instrument.

The gear *d* meshes with a pinion, *h*, on a little shaft or spindle, *i*, on which is fixed a toothed escape-wheel, *j*. With this meshes an anchor, *k*, on a spindle, *l*, on which is fixed a vibrator, *m*, or short pendulum acting as an escapement. The mechanism thus described constitutes the slow-movement gear for retarding the descent of the carbon-holder. When the carbon-holder is released, its weight acts upon this train of gearing, rotates the wheels, and vibrates the escapement, which acts to limit the rotation of the wheels, and consequently to prevent the descent of the carbon-holder at too rapid a rate.

The spindles *c*, *i*, and *l* of the slow-movement gear have bearings in a frame, F′, which is fixed to the frame F, instead of being a pivoted frame movable up and down, as heretofore. In the construction here shown the slow-movement gear constitutes also the feeding mechanism. The armature-lever *n* of the shunt-magnet S extends beyond its pivotal axis and terminates at *p* over the vibrator *m* in such position that when the magnet relaxes and the armature is drawn up by the retracting-spring *o* this end *p* descends into the way of the vibrator *m* and intercepts its movement. The end *p* may constitute a stop by dropping into the path of the upper end of the vibrator, or it may constitute a brake by extending over the upper end of the vibrator and dropping down thereupon when released.

The "lifting-gear" D for striking the arc consists of a pinion, *q*, which meshes with the rack *b* on the carbon holder, a spindle, *r*, for this pinion, an escape-wheel, *s*, on this spindle, and an escapement anchor, *t*, on a spindle, *u*, on which is fixed a vibrator, *v*. This mechanism is hung in a frame or lever, E, which affords bearings for the spindles *r* and *u*. This frame is pivoted or fulcrumed between screws *x x*, is counterweighted at E′, and at its opposite end is jointed to the core M′ of the main-circuit solenoid M; or if a magnet be used instead of a solenoid the free end of the frame E will bear its armature.

It is desirable, but not essential, that the lifting-gear be provided with a ratchet and pawl interposed between pinion *q* and escape-wheel *s*, to facilitate the lifting of the carbon-holder in order to insert new carbons.

The operation is as follows: When the current is first turned on, it excites the solenoid M, which draws up its core, and thereby lifts the free end of the frame E, and with it the lifting-gear D and the carbon-holder B, thus separating the carbon pencils and establishing the arc. While the carbon-holder is thus lifting the pinion *a* and ratchet-wheel *c* of the slow-movement gear turn backward. When the carbon-holder is lifted, it is caught by this gear and held elevated, since this gear is prevented from operating by the stop *p*. This continues until the arc burns too long, whereupon the shunt-magnet acts, the stop *p* is lifted, the slow-movement gear is thereby freed, and the carbon-holder descends slowly until the arc is shortened to its normal length, when the shunt-magnet releases its armature and the stop *p* drops and again holds the gear C. If the current should be momentarily interrupted, thus extinguishing the arc, the solenoid M would release its core and the frame E would drop. On the resumption of the current it would excite the shunt-magnet, thereby releasing the slow-movement gear and permitting the carbon-holder to run down until the carbons touched, when immediately the solenoid M would act to re-establish the arc. If a quicker action be desired, the frame E may be provided with a screw-leg, *w*, Fig. 1, which, on the dropping of the frame E, will strike the armature-lever and depress it to the same effect as though the shunt-magnet were excited, thus releasing the stop *p* and permitting the carbon-holder to run down and re-establish the main circuit. As the carbon-holder feeds downward, it rotates both systems of gearing and vibrates both vibrators *m* and *v*. The lifting-gear normally does not materially resist the descent of the carbon-holder, since its escapement works very freely and is not geared up, as in the slow-movement gear. In the act of lifting the anchor *t* engages the wheel *s* firmly and acts for an instant as a pawl, but immediately the lifting-pressure is relaxed it becomes a free escapement. The slow-movement gear effectually prevents any pumping downward of the carbon-holder, since the escapement is so adjusted as to permit of movement no faster than that which is desirable in feeding—namely, a movement somewhat more rapid than the rate of consumption of the carbons, but not rapid enough to produce any flickering or flashing of the light. The slow-movement gear also effectually resists any pumping upward of the carbon-holder by reason of the tension of the spring *g* of the ratchet and pawl, as already described. This tension should be sufficient to resist any sudden lifting tendency of less energy than the lifting movement of the main-circuit solenoid, which is necessarry to establish the arc.

Figs. 4 and 5 show a different construction. Here the slow-movement gear C has no function except to retard the descent of the carbon-holder and prevent pumping. Two solen-

oids, M S, are employed, pulling oppositely upon one core, which is pivoted to the frame E, as before. This frame bears the lifting-gear, which in this construction acts also as the feeding-gear. This gear consists of pinion *q*, (meshing with rack *b*,) mounted on spindle *r*, gear-wheel *s'* on the same spindle, connected to the pinion through the medium of a ratchet and pawl, in order to permit the free lifting of the carbon-holder, a pinion, *t'*, gearing with said wheel and fixed on a spindle, *u'*, a brake-wheel, *v'*, on said spindle, and a fly or fan, *f'*, also on said spindle. Above the frame E is pivoted a brake-lever, G, which is drawn by a tension-spring, *g'*, against an adjustable stop, *h'*. As the frame E rises above the position shown, the brake-lever yields and rises with it, holding the brake-wheel from revolving; but when the frame descends below the position shown the brake-wheel is freed from the brake, and the gear is free to revolve, limited in its speed only by the fan *f'*. At starting, the solenoid M lifts the core, frame, and carbon-holder high enough to establish the arc and to bring the friction-wheel against the brake. As the arc lengthens, the shunt-coil S pulls more and more, until finally it draws down the frame E until the wheel is freed from the brake, whereupon a feeding of the carbon-holder takes place until the arc is sufficiently shortened, when the shunt-coil relaxes and the main coil again lifts the frame slightly, thus carrying the wheel against the brake and stopping the feed.

I have thus shown two alternative and equivalent methods of operation—viz., first, controlling the feed by the action of the shunt-magnet on the slow-movement gear, and, second, controlling the feed by the opposing action of a main and shunt solenoid (or electro-magnet) on the lifting-gear. In the former case it is the slow-movement gear, and in the latter case it is the lifting-gear that constitutes the feeding mechanism. I have also shown two equivalent methods of retraction—viz., a vibrating escapement and a fan or flier—and two equivalent methods of stopping and feeding—viz., by a stop and by a brake—and by moving the stop or brake to or from a stationary vibrator (or wheel) on the one hand and moving a wheel (or vibrator) toward or from a stationary brake or stop on the other.

My slow-movement gear may be used in other types of electric-arc lamps, being in general a substitute for dash-pots.

I claim as my invention—

1. In an electric lamp, the combination, with a magnet in the main circuit and gearing connected therewith and actuated thereby for raising the carbon to establish the arc, of a magnet in a shunt-circuit, and independent slow-motion gearing mounted in a stationary frame and connected with the shunt-magnet and adapted to regulate the descent of the carbon, substantially as set forth.

2. The combination, with a rack and-pinion arc lamp, of a slow-movement gear meshing with a rack on the carbon-holder, mounted in fixed bearings and adapted to resist any tendency to downward pumping of the carbon-holder, and a ratchet and pawl forming part of said gear, and having a tension-spring for the pawl of strength sufficient to resist transitory tendencies to upward pumping of the carbon-holder, but insufficient to resist the lifting force of the main-circuit magnet for establishing the arc, substantially as set forth.

3. In an electric-arc lamp, the combination, with the carbon holder or rod, of two separate gearings engaging with the carbon rod, one of said gearings being a slow-motion gear and mounted in a stationary frame and the other constituting a lifting-gear and mounted in a movable frame, and a main magnet included in the arc circuit and a shunt-magnet included in a constantly-closed shunt-circuit around the arc, said magnets and gearing being combined and arranged to automatically establish the arc, regulate its length, and feed the carbon, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

GUSTAV PFANNKUCHE.

Witnesses:
WILLIAM P. MOULTON,
OSCAR FAULHABER.