THE APPLICATION OF STEAM TO CANALS.---NO. I.

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The immense capital invested in canal property, and the extended lines of inland navigation throughout the various districts of Great Britain, Northern Europe, and the United States of America, cause regret that, while so much has been done in years past to develop the trading interests of these countries, such extensive internal communications have been suffered to remain dormant, burdened by the same defective system of navigation which, once ample for the transportation of goods, when the pack horse and the country wagons were their only competitors, now is in most miserable contrast with the perfected system and dispatch that characterizes the management of the railways of the present day. The defects and delays in the transportation of goods *via* canal, not lessened by the private interests and conveniences of drivers, boatmen, and others engaged in their traffic, where heavy boats are dragged from one destination to another at the slowest possible speed, by the wretched beasts that lean for support against the towing lines, point to the necessity of a radical change, to redeem them from the position to which they have sunk, in the competition of the day.

Commencing with the early history of canals, we propose to present some of the more prominent experiments which have been designed to improve the construction of vessels adapted to inland navigation, and the application to them of mechanical means of propulsion.

Save that the large drains cut by the early churchmen in the Cambridge fens seem to have been employed for purposes of occasional inland navigation as early as the fifteenth century, the great commercial republic of Holland may safely claim centuries of European priority in the construction of a system of artificial water-roads, which the industry of its people had turned to a good account of prosperity and power. France, Sweden, add even semi-barbarous Russia, had also taken the lead in this respect long before England had entered upon her career of canal construction; though in Egypt, long before the invasion of Great Britain by the Gauls, and in China, at a still earlier date, we know of their introduction, yet their origin is undoubtedly merged in the system of irrigation which, for unknown ages, has been pursued in those countries.

Certain authorities have claimed that during the invasion of England by the Romans, the works executed by them in the Fen districts were also used for navigable purposes, but of this we have no tangible proofs. In 1623, however, we find from Parliamentary records that Sir Hugh Myddleton was engaged in considering a bill "For the making of the River Thames navigable to Oxford;" while, twenty-three years later, one Francis Mathew addresses, to Cromwell and his Parliament a paper upon the immense advantages of opening up a water communication between London and Bristol, which purposed making the rivers Isis and Avon navigable to their sources, with a short canal to connect their heads across the intervening country; but, for Mathew's time, a scheme for the construction of three miles of canal, even by the State, was far too daring, and a century elapses before a canal is made in England.

Andrew Yarrington, gentleman, next publishes, in 1677, a curious book, entitled "England's Improvements by Sea and Land, to outdo the Dutch without fighting, to pay debts without moneys, to set at work all the poor of England with the growth of our own land," in which he strongly contrasts the prosperous energy of the Dutch, especially regarding their inland water communication, with the passive indifference of Englishmen to the immense advantages in their numerous streams and rivers, lying dormant at their very doors, wanting only improvement in their existing beds, with proper connection, to develop the trade and prosperity of the country.

To the lack of capital at this time can be traced the secret of the little progress of the internal communication of the country, and, though Parliament liberally granted permission for river improvements, yet, from the want of money, few were attempted, or, if commenced, failed from the same cause.

About the beginning of the eighteenth century, the opening of the navigation of the rivers Aire and Calder gave a great impetus to the trade of that portion of Yorkshire, and stimulated the demand for improvements in inland navigation; and we find its first fruits in an act of 1720, to make navigable the Mersey and Irwell, from Liverpool to Manchester; and, at about the same time, acts for the improvement of the Weaver, Douglass, and the Sankey navigations were granted, and, what was more to the purpose, the works carried out. Again, in 1817, as a reference to the pamphlets of the British Museum will show, Dr. Thomas Congreve published some views, headed "A Scheme and Proposal for making a Navigable Communication between the rivers Trent and Severn, in the County of Stafford," which paper project slumbered for forty years, till, in 1755, a survey was made for this very line of canal, under the auspices of the "Liverpool Corporation of Merchants," which line proceeded by Chester to Stafford, Derby, and Nottingham; and from Brindley's "Note-book" we find that he executed a fresh survey over the same ground in the years 1759-60, but at the expense of Earl Gower and Lord Anson.

Thus, it is not till the middle of the last century that English enterprise was fairly awakened to the necessity of a system of artificial canals; and directly traceable to the execution and extension of these earlier river improvements, can we date the present system of internal communication, which has conduced so largely to the industrial prosperity of the English nation; and to the consequent increase of British manufactures, and their distribution, do all countries owe many of their indispensable comforts of life.

Apart from the deductions that would naturally follow from the river improvements, it is well known that, in 1755, the deepening and widening of the Sankey-brook, tributary to the Mersey, with the application of a floodgate for retaining tide water, gave the hint which culminated in the construction of the well known Bridgewater canal, under James Brindley; but the rapidity of extension was afterwards such that, between the years 1760 and 1803, no less than 2,295 miles of canal were opened. From the exceedingly interesting history of this society, written by Mr. Davenport, we learn that the gold medal of the Society of Arts was awarded, in 1800, to the Duke of Bridgewater, as the father of inland navigation, and for his general exertions in promoting the interests of inland water carriage; since which date there seems to be no note of special award to the workers in this particular field of the economy of the nations. Indeed, since the adoption of canals, except in the substitution of horses for men at the towing lines, and some improvements effected in the manner of passing boats from one level to another, they may be truly said to have remained stationary in the general march of improvement, and, unlike all other arts, have partaken of none of the benefits arising from the increase of mechanical science.

It is with the view of calling attention to the fact, that, by the exercise of a tithe of the mechanical ingenuity which has been expended on railways, canals might again assume a position and importance which, if not in general economy superior to railways, yet may, in relative utility, compete in the transit of minerals, and other merchandise, that this paper is now before you; and the immense capital embarked in canals certainly renders it a subject of national as well as pecuniary importance.

A further enumeration of the progress of canal construction in this country is unnecessary, yet a glance at the commencement of inland works in America will be interesting; and in connection we find, as early as 1724, Cadwallader Colden, then Surveyor General of the colony of New York, suggesting a system of works somewhat similar to those now existing. Sir Henry Moore, the Governor of the colony, in 1768, also recommended the improvement of the inland navigation. These recommendations slumbered through the Revolutionary war which followed, to be again projected with the independence of the country. As in England, the improvement of the existing navigations was first in course, and, as early as 1791, acts for surveys and estimates relating to the removal of obstructions to the navigation of the Hudson and Mohawk rivers were passed. In the following year, the Western and the Northern Inland Companies were incorporated, and, by 1802, the former company had succeeded in spending an immense sum of money, with but very small proportional results. The route now occupied by the Great Erie Canal was adopted in 1812, repealed in 1814, to be again revived two years later. Ground was broken near Rome in July of the same year, while the first boat passed from Lake Erie to the Hudson in October, 1825, thus consuming a little over eight years in constructing the distance of 364 miles, with a total of 71 locks. The Champlain Canal was commenced in 1816, and completed in 1823, since which date the many lateral branches of the Erie have been added to the system, and the application of inland navigation extended to many of the other States.

It is a fact of interest, that the original dimensions of these canals were established by the commissioners, in 1817, at 40 feet in width by 4 feet deep, with locks 90 feet by 15; but, as early as 1834, the wants of a growing commerce demanded an increase of capacity, and in 1835, an act of enlargement of the Erie Canal was passed, since which time the depth has been increased to 7 feet, its width to 70, and the locks to 18 by 110 feet. Before the commencement of the Erie, the cost of transporting a tun of merchandize from Buffalo to Albany equaled £20, and consumed twenty days; the canal at once reduced the cost to £4, or one fifth, and the time to eight days. But mark, that the mere enlargement of the canal again reduced the average cost of movement, including all tolls, to ten shillings per tun, or one eighth of the expense previous to the improvements.

It may be interesting to review some of the more or less ingenious attempts to overcome the disadvantages of towing by horses, and hastily glance at the various methods of propulsion by mechanical means which have been especially designed to supersede animal labor in propeling boats on inland navigable waters, in Europe and America, up to the present time. In this enumeration, we shall necessarily find, among the first experiments, some which have been broadly designed for purposes of general navigation, and touch upon the early history of the steam engine; but, so far as possible, preference will be given to those where application to canal or river navigation has been the paramount idea of their inventors.

CARAVANS.

Every caravan is under the command of a chief. When it is practicable, they encamp near wells or rivulets, and observe a regular discipline. Camels are used as a means of conveyance, and there are generally more camels in a caravan than men.

The commercial intercourse of Eastern and African nations has been principally carried on, from the remotest period, by means of caravans. The formation of caravans is the only way in which it has ever been possible to carry on any considerable internal commerce in Asia or Africa. The governments that have grown up in these continents have seldom been able, and seldom have they attempted, to render traveling practicable or safe for individuals. The wandering tribes of Arabs have always infested the immense deserts by which they are intersected, and those only who are sufficiently powerful to protect themselves, or sufficiently rich to purchase an exemption from the predatory attacks of these freebooters, can expect to pass through territories subject to their incursions without being exposed to the risk of robbery and murder.

In the pilgrimage to Mecca enjoined on the followers of Mohammed, the prophet grants them the privilege of trading: "It shall be no crime in you if ye seek an increase from your Lord by trading during the pilgrimage." The camels of each caravan are loaded with those commodities of every country which are of easiest carriage and readiest sale, and during the latter part of the month of June and the early part of July, the Holy City is crowded with opulent merchants and zealous devotees. A fair or market is held in Mecca on the twelve days that the pilgrims are allowed to remain in the city.

Few pilgrims, says Burckhardt, except the mendicants, arrive without productions of their respective countries for sale. Pilgrims from Morocco and the north coast of Africa bring their red bonnets and woolen cloaks; the European Turks, shoes and slippers, hardware, embroidered stuffs, sweetmeats, amber, trinkets of European manufacture, knit silk purses, etc.; the Turks of Anatolia bring carpets, silks, and Angora shawls; the Persians, cashmere shawls and large silk handkerchiefs; the Affghans, tooth brushes, made of the spongy boughs of a tree growing in Bokhara, beads of a yellow soapstone, and plain coarse shawls manufactured in their own country; the Indians, the numerous productions of their rich and extensive regions; the people of Yemen, ornaments for Persian pipes, sandals, and various other works in leather; and the Africans bring various articles adapted to the slave trade. The pilgrims are, however, often disappointed in their expectations of gain: want of money makes them hastily sell their little adventures at the public auctions, often at very low prices.

The two principal caravans which yearly rendezvous at Mecca are those of Damascus and Cairo. The first is composed of pilgrims from Europe and Western Asia; the second, Mohammedans from all parts of Africa. The Syrian caravan is said by Burckhardt to be very well regulated. It is always accompanied by the Pasha of Damascus, or one of his principal officers, who gives the signal for encamping and starting by firing a musket. On the route, a troop of horsemen ride in the front, and another in the rear, to bring up the stragglers.

The different parties of pilgrims, distinguished by their provinces or towns, keep close together. At night torches are lighted, and the daily distance is usually performed between 3 o'clock in the afternoon and an hour or two after sunrise on the following day.

The Bedouins or Arabs, who carry provisions for the troops, travel by day only, and in advance of the caravans, the encampment of which they pass in the morning, and are overtaken in turn and passed by the caravan on the following night at their own resting place. At every watering place on the route is a small castle and a large tank, at which the camels water. The castles are garrisoned by a few persons, who remain the whole year to guard the provisions deposited there. It is at these watering places, which belong to the Bedouins, that the sheikhs of the tribe meet the caravan, and receive the accustomed tribute for allowing it to pass.

The caravan which sets out from Cairo for Mecca is not generally so large as that of Damascus, and its route along the shores of the Red Sea is more dangerous and fatiguing. But many of the Africans and Egyptian merchants sail from Suez, Cosseir, and other ports on the western shore of the Red Sea, for Djidda, whence the journey to Mecca is short and easy. The Persian caravan for Mecca sets out from Bagdad; at many of tho Persians are now in the habit of embarking but Bussorah, and coming to Djidda by sea.

Caravans from Bagdad and Bussorah proceed to Aleppo, Damascus, and Diarbekir, laden with all sorts of Indian, Arabian, and Persian commodities; and large quantities of European goods, principally of English cottons imported at Bussorah, are now distributed throughout all the Eastern parts of the Turkish Empire by the same means. The intercourse carried on in this way is every day becoming of more importance.

The commerce carried on by caravans in the interior of Africa is widely extended and of considerable value. Besides the great caravan which proceeds from Nubia to Cairo, there are caravans which have no object but commerce, which set out from Fez, Algiers, Tunis, Tripoli, and other States on the seacoast, and penetrate far into the interior. Some of them take as many as 50 days to reach the place of their destination, traveling at the rate of from 18 to 23 miles per day.

The trade of these caravans is a barter of various kinds of goods for slaves. Three distinct caravans are employed in bringing slaves and commodities from Central Africa to Cairo. They do not arrive at stated periods, depending upon the success they have had in procuring slaves, ivory, gold dust, drugs, and such other articles as are fitted for the Egyptian markets. The largest of these caravans, the Darfur caravan, consists of 2,000 camels, and its departure is looked upon as a most important event, and for a while engages the attention of the whole country.

Caravans are distinguished into heavy and light. Camels loaded with from 500 to 600 pounds form a heavy caravan; light caravans being the term applied to designate those formed of camels under a moderate load or half a load.

No particular formalities are required in the formation of caravan. Those that start at fixed periods are mostly under the control of government, by whom the leaders are appointed. But any dealer is at liberty to form a company and make one. The individual in whose name it is raised is considered as the leader, unless he appoint some one else in his place. When a number of merchants associate together in the design, they elect a chief, and appoint officers to decide whatever controversies may arise during the journey.

Paine's Electro-magnetic Improvements.

These improvements are covered by several patents, granted to H. M. Paine, of Newark, N. J., in 1870 and 1871, and we shall allude to them in this description by their patent numbers, quoting chiefly from the specifications of the patents.

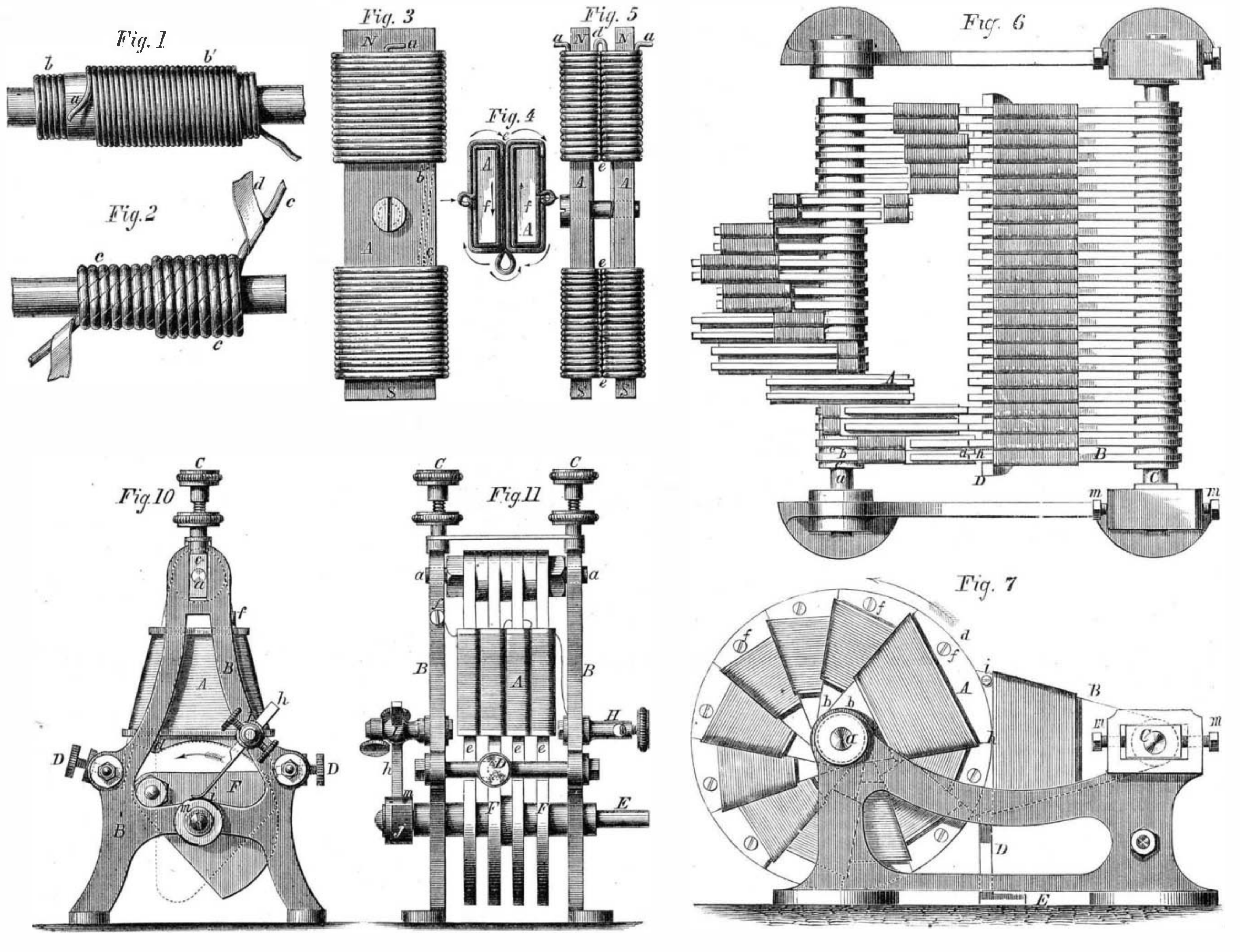
Figures 1 and 2 are illustrations of patent No. 103,231, being an improvement in the construction of electro-magnets. The object of the invention is to increase the power of electromagnets by neutralizing the induced currents, and thus rendering available the full dynamic value of the battery. The improvement consists in the interposition, between the layers of coils, or the application as a clothing or covering to the insulated wires of which the coils are composed, of a metallic medium, by which the antagonism of like currents to each other is neutralized. Tho metallic medium which may be employed may be of various kinds, but that which it is now proposed to use, as most convenient for the purpose, is what is known as metalfoil. The medium may be applied tion, their course is directly opposite, as shown by the arrows, *f f*, in Fig. 5, which is an end view of Fig. 3.

CLAIM.—The compounding or binding together of bars, separately wound, and in the same direction.

Figs. 6 and 7 illustrate patent 103,229, being an improvement in magnetic engines. The invention relates to a peculiar and novel mechanical arrangement of a sector mag net for purposes of motive force, which has for its object economy of space, cost of construction, and rigidity of parts. The value of the magnet attraction being inversely as the square of the distance, it becomes necessary, in order to obtain the best results, to work the poles in as close juxtaposition as possible. To accomplish this requirement, even in very small engines, with the poles working with a between-space of $\frac{2}{100}$ths of an inch, without contact by spring of frame or other parts, requires a heavy cumbrous frame and shaft. To avoid this necessity, both the rotating and fulcrum magnets are so arranged that all strain of attraction will be longitudinal section of the sector limbs to the strain. The fulcrum magnets, B, are bound on one common bolt, C, Figs. 6 and 7, in the same manner that the rotating magnets, A are held, and their poles, *h*, are bound by the rods, *i*, passing through the whole series, which makes one uniform breast of sector limbs, the axis of all lying in one common plane. As in the rotating magnets, so in these, all the strain is met and resisted by the longitudinal section of the limbs, and this extreme stiffness of construction allows the two series of magnets to be brought in close and accurate range of motion by means of the adjusting screws, *m*. The magnets, A, revolving in the direction of the arrow, will subject the fulcrum magnets, B, to a downward strain, which is met by the bridge, D, resting firmly on the bed plate, E.

CLAIM.—First. The arrangement of the magnets on the shaft. Second. The breast of fulcrum magnets in their com bination with the rotating magnets, A.

Figs. 8 and 9 illustrate patent No. 103,768, being an im



PAINE'S ELECTRO-MAGNETIC IMPROVEMENTS.

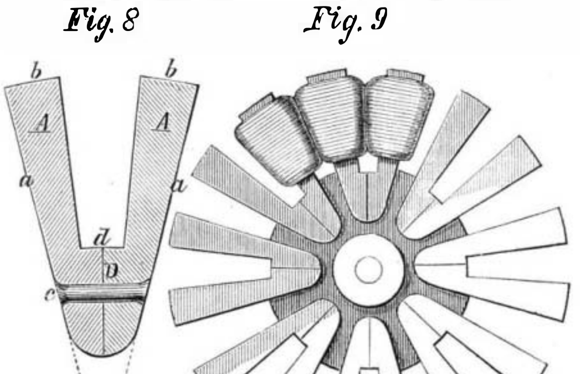
in various ways, but for illustration there are shown in the engravings two ways of applying it. In Fig. 1, metal foil, *a*, in the form of a sheet or ribbon, is shown wound or lapped around and between the successive layers of coils, *b b*, of insulated wire. In Fig. 2, the entire length of the insulated wire is shown as having a ribbon, *d*, of metal foil wound around it, to form a complete clothing or covering.

CLAIM.—The interposition of a metallic medium between the layers of the coils of an electro-magnet, or the application of a metallic medium as a clothing or covering to the wire of an electromagnet.

Figs. 3, 4, and 5, illustrate patent No. 103,230, being an improvement in electro-magnets. The object of the invention is to obtain the same relative results by compounding electro-magnets as are acquired by the compounding of permanent magnets. In order to accomplish this result, the poles of two or more rectangular bars, A, Figs. 3 and 4, are wound with insulated wire, commencing at *a*, Fig. 3, on each bar, and winding around the requisite number of turns to reach the guide pin, *b*, and then pass down to guide pin, *c*, and wind in same direction till the same number of turns has been made on the opposite end of the bar: then return up to guide pin, *c* and *b*, and up to commencement, *a*. Having thus wound two or more bars (all being wound in the same direction), they are bound together, as shown in Fig. 4, and connection is made between the coils at *d*. It is not proposed to obtain any valuable result from magnetic induction by this method of constructing electro-magnets, but an increased dynamical value is claimed from the action of the currents on each other. It is well known that electrical currents moving in opposite directions accelerate each other, and, although the currents are moving in the same direction around the axis of all the bars, yet, at the juncture, *e*, Figs. 4 and 5, of the combina-

resisted by the longest cross section of the magnets themselves, and thus just in the ratio that the magnets are en larged the increased strength is met. Any required number may be taken, of magnet sector limbs, A, Figs. 6 and 7, and they should pass the driving shafts, *a*, Figs. 6 and 7, through their several tie bolt ends, *b*, with washers, *c*, between, to secure even spacing for the current wire. These sector limbs

Fig. 8 Fig. 9



are then so arranged on the shaft as to make the poles, *d*, describe a circle as regards their path of rotation, and a thread of one or more revolutions as regards the length of the shaft. They are then bound in their position by the nuts, *e*, and screw bolts, *f*, which pass through one series of limbs into the next, till the whole series is securely held in its required position. It will be seen that this combination presents the provement in sector electro-magnets. This improvement relates to shaping the limbs of sector magnets in such wise that they will describe radial lines, and thus form a compact mass, when brought together around a common axis. The limbs, A A, Fig. 8, are made separate, and their outer lines, *a a*, taper from the poles, *b b*, toward their junction, D, at angles that will meet at the center of the shaft, which forms the center of motion around which they rotate. The junction of the limbs is shouldered, *d*, so as to secure a space between them for the current coils, and screw bolts, *c c*, or rivets, bind the limbs together. Fig. 9 represents a wheel made up of these radial magnets.

CLAIM.—The construction of radial limbed magnets, substantially as described.

Figs. 10 and 11 illustrate patent No. 103,228, being an im provement in electro-magnetic engines. A sector magnet, A, Fig. 10, is suspended in a frame, B, the tie bolt, *a*, being seated in an adjustable box, *c*, which is operated by the milled head screw, C. D D are adjusting screws, which operate as lateral adjustments of the magnet, A. On the driving shaft, E, Figs. 10 and 11, a sector armature, F, whose links correspond in number and position with the links of the magnet, A, is keyed. The radius of this armature, if described from the center of the shaft, E, and the curve, *d d d*, Fig. 10, described in the poles, *e e e e*, Figs. 10 and 11, of the magnet, A, must coincide with the radius of the armature, the vertical and lateral adjusting screws, C and D, determining the proper distance between the poles of magnet and armature, which, to secure the best results, should be only sufficient to avoid the friction of actual contact. One end of the wire around the magnet, A, is secured to the frame at *f*, Figs. 10 and 11, and the other end to a pole binder, H, Fig. 11, which is electrically insulated from the frame. Another pole binder, I, Figs. 10 and 11, also electrically insulated from the frame, holds a spring arm, *h*. Fig. 10, which rests on a circuit breaker, *i*. The operation of this arrangement is such that, when the arm, *h*, rests on the non-conducting portion of the circuit breaker, no current can traverse the links of the magnet, but, when the conducting part, *m*, comes in contact with the arm, *h*, a circuit is made, and the armature made to rotate during the contact. Having thus described the mechanical details of the application of the sector magnet to the production of rotary motion, we will proceed to describe the mode of utilizing the reflex currents. Referring to Fig. 10, and considering the armature to be revolving in the direction of the arrow, and supposing that the circuit breaker is so adjusted, with reference to the arm, *h*, as to continue the action of the current till the axis of the magnet and armature are coincident, and then break, we should find that the reflex action of the current would resist any attempt of the armature to continue its onward motion, and this resistance is equivalent to seventy-five per cent of the battery current. But, if the adjustment of the circuit breaker be such that the current is broken previous to the coincidence of axis of the magnet and armature, then the reflex current, instead of retarding the motion of the armature, will expend itself in assisting its motion; therefore, in order to convert this reactionary property of the currents into a valuable element of force, the circuit breaker is adjusted under such conditions as will insure a break previous to the coincidence of the axis of the magnet and armature, as shown in Fig. 10, the dotted lines showing the position that the armature obtains through the action of the reflex currents, the break having been made when the armature was in the position shown by the full lines.

CLAIM.—First. The combination of the sector magnet, A, and sector limbed armature, F, with their adjustments or without. Second. The breaking of the circuit previous to the coincidence of the axis of magnet and armature, substantially in the manner specified.

Breweries and their Fittings.

A paper "On the Machinery and Utensils of a Brewery," was read before the Society of Engineers, in the hall of the Westminster Palace Hotel, London, by Mr. Thomas Wilkins, C.E.

The size of a brewery is stated in the number of quarters of malt that can be used in one brewing; thus, a brewery having a mash tun in which twenty combs of malt can be mashed at a brewing, would be a "ten quarter brewery," and so on, the rest of the plant being made in proportion.

Until steam came into general use as a motive power, all the labor was done by hand or horse power; sometimes a water wheel was used; but it is believed that on no occasion has wind power been applied. Of late years, steam has not only been used in breweries as a motive power, but also as a means of transmitting heat; so that the brewer having a boiler to supply steam to the engines, uses it also to supply steam for boiling both liquor and wort, either by forming the boiling coppers with an outer pan or jacket of iron, and passing steam through the space between that and the inner pan of the copper, or by passing the steam through coils of copper pipe fixed at the bottoms of vessels made of wood, iron, or copper, whichever of these be preferred.

In building a brewery every advantage should be taken of any favorable natural features of the locality, such as a hill side, where the building may be arranged so that the utensils can be placed in a position one above another in level, taking advantage of the natural slope to save labor, which might otherwise have to be expended in pumping the worts or beer about. A good supply of suitable water, or "liquor," as it is called in breweries, is also indispensable. That there is this should always be ascertained before either building a new brewery or extending an old one.

The mash tun should be made either of good yellow deals or of oak, and should have a false bottom, generally of iron, made of several plates, so as easily to be removed for cleansing the tun. These plates are very closely perforated with holes about one twelfth of an inch in diameter; sometimes, however, with slots that width, but about two inches to three inches long, cast in them. These slots and also the small holes are about three eighths of an inch on the bottom side of the plate, being made so much taper to prevent their blocking. The plates with slots are more expensive than the others, but some brewers prefer them. The mash tun should contain from eighteen to nineteen cubic feet for every quarter of malt. Formerly, when the crushed malt had been placed in the tun, the nearly boiling hot liquor was run in, and the whole was thoroughly mixed together by men with poles, each having several cross pieces, about the size of the staves of a ladder, in one end. This operation is termed mashing, and these oars are still used by some brewers, more especially where a "Steele's" or a similar machine is used.

A better and more certain method of mashing was required; for it was found that in some parts of the mash tun a sort of cake or dumpling would be formed, the outside of which, consisting of a pasty mass of flour, prevented the liquor reaching the inside, to extract the valuable ingredient of the malt. The machine which for many years has been fitted to mash tuns, to perform this operation, is made as follows: A circular crank, with radial teeth, is bolted to the sides of the mash tun; a vertical shaft is erected in bearings in the center of the tun. This shaft is either carried some few feet above the top of the tun, or else passes through a stuffing box in the bottom, and is worked by bevel wheels from a horizontal shaft. The vertical shaft supports loosely a bearing which carries one end of a second horizontal shaft, which is inside the tun, at about half its depth. The other end of this shaft has a pinion keyed upon it. This pinion gears with it, and is supported by the circular rack before mentioned. A revolving motion is given to this horizontal shaft by bevel wheels from the vertical one, and upon it is hung a sort of rake, which, as the shaft revolves, thoroughly mixes up the mash. Sometimes there are two, and even three of these rake shafts. It will be obvious that, as these shafts revolve, the pinion gearing into the fixed rack causes the whole to revolve somewhat slowly round the tun.

In large breweries, where there are sometimes a dozen or more mash tuns, rather than have a large engine, it is better to have a small one to pump all the liquor, and another to grind the malt; and these may be kept at work all day, preparing for the morrow. Indeed, a vast amount of money in first cost, and in labor afterwards, may be saved by properly planning and arranging everything beforehand.

TOY STEAM ENGINE.

This is a very simple and pretty toy engine, consisting of very few parts. It is the invention of Philander Macy, of Rochester, N. Y. It is a beam engine with oscillating valve

gear, and the pedestal upon which it stands is the boiler. By filling the boiler and setting it upon a stove, the engine will work as long as the water supply lasts.

Cracked Sovereigns.

It has probably fallen to the lot of many readers to have come into possession occasionally of gold or silver coins which were hollow, or cracked on their edges, and therefore not sonorous when tested by the well known "ringing" process. Speculations as to the source of the imperfection are numerous, and various theories have been advanced and discussed in regard to it.

Perhaps one of the most extensively prevailing notions as to the origin of cracked sovereigns and cracked coins of other denominations, is, that all pieces of money fabricated at the British mint are, in the first place, made in halves, the heads and the tails being afterwards paired and united by cementing, soldering, hydraulic pressure, or some other means. This operation being in some cases imperfectly performed (as it is argued), a partial or complete divorce may afterwards take place, and hence the phenomena of cracked moneys.

Another supposition is, that the hollow coins have been tampered with by gamblers for their own nefarious purposes. Neither of these theories, however ingenious they may be, is the correct one. The evil really arises in the way we shall attempt to describe. All the legitimate metallic money of this country is made from bars of cast gold, silver, or bronze. At the Royal mint there are orthodox sizes for these bars, so as to produce each variety of coin in use outside its walls. Those for sovereigns are twenty-six inches long, one and a half inches wide, and one inch thick; and, for the purpose of facilitating explanation, let us confine our attention to gold only.

Such bars are cast in vertical molds of iron, which latter are fitted together in halves, so as to allow the giant nuggets to be realized easily from within them. On filling a mold from the crucible of molten metal held over its mouth, the resulting bar cools rapidly. Those parts of the bar which touch the sides of the mold cool first, and more gradually the center is reduced in temperature. As the sides of the bar harden at once, they cling, as it were, to the walls of the mold, whilst the metal in the middle contracts in cooling, and subsides down the mold. The upper end of a bar of gold resembles much at this juncture the mercurial column in a barometer when the "glass" is said to be "falling." It is hollow or depressed in the middle, and sometimes very much so, the depression occasionally extending to one inch.

The lower end of the bar is perfectly squared, because the base of the mold is square. When removed from its iron case, the bar is carried to the rolling mill for lamination. It is passed again and again between the rollers, until it is attenuated into a strap or ribbon; but that which was its upper end is still defective. The rollers have simply compressed the precious metal, and therefore left the hollow end a mere crevice or thin line in the middle of the strap. This end is considered as scrap, and, first cut off by a pair of shears, it is returned to the melting pot. It happens, sometimes, nevertheless, that a sufficient portion of imperfect ribbon is not cut away, the crack thus extending beyond the amputating point. When this occurs, it creates the evil of "cracked sovereigns." The ribbon is removed to the punching press, and perforated from end to end by a punch of the exact size of a sovereign. Some of the disks of metal thus produced *may* be cut from the bad end of the strip of gold. To detect these criminals, if they exist, a small staff of boys is employed. They are each armed with a bright-faced anvil block of cast iron, and they ring every individual disk in very rapid succession on the anvil. The sound and perfect pieces give forth harmonious music, whilst the others are dumb dogs, and have no music in their souls. The defaulters are, or should be, all picked out, and condemned to the "fiery furnace" once more. Boys are not infallible, and they have permitted "dummies" to escape now and then. These pass forward to be stamped at the presses, milled on their edges, and issued to the public, by whom they are criticised, and justly condemned. The hollowness of their characters is only detected, it may be, after some contact and friction with their neighbors, just as speciousness in the human character is only found out by the application of the tests of adversity and trouble. With the care at present exercised at the mint, hollow coins cannot escape detection.

Correspondence.

The Editors are not responsible for the opinions expressed by their Correspondents.

Utilizing Coal Dust for Fuel.

MESSRS. EDITORS:—Bringing into practical use the coal dust or slack coal, is today the great question; and as you have given space in your columns to a great many communications on the subject, will you do me the favor to insert this letter on the manufacture of artificial fuel or compressed coal dust?

It is a well known fact that coal, either bituminous or anthracite, produces in mining, breaking, screening and handling, an amount of dust, commonly known as slack coal, amounting, on an average, to 50 per cent of the coal production, thus causing a considerable loss to the parties engaged in mining, as but a small portion of this dust coal, and that only of the bituminous coal, is needed for blacksmith purposes, while the anthracite slack is entirely useless. The immense quantity of refuse coal must necessarily be got out of the way, whether dumped into a stream, to be carried off, or heaped on ground which has to be dearly paid for.

In the anthracite coal regions, this immense amount of waste is constantly being piled up around the mines in vast, unsightly mounds, burying the mining villages, and sadly encroaching on the limits of many of the chief towns. The amount of this waste cannot be less than fifteen millions of tuns, and every year adds to the rapidly increasing dirt bank.

In France, in Germany, in Belgium, and in England, the slack of the bituminous coal has been converted into lumps or cakes of different sizes and shapes by mixing it with coal tar. Monsieur Dehaynin, from Paris, started the first manufacture of artificial fuel or agglomerated slack, at Montigny-sur-Sambre (Belgium) about eleven years ago. He possesses today two manufacturies in Belgium and two in France. He manufactured in 1870 over 1,200,000 of tuns; railroad companies used 931,600 tuns, the navy used 250,000 tuns, and other industries used 70,000 tuns.

Among the railroad companies, that of the Paris, Lyons, and Mediterranean consumes pressed coal exclusively, requiring 1,200 tuns per day. The Northern Railroad Company, of France, between Paris, Amiens, Dunkerque, and Calais, does not use pressed coal exclusively, although its daily consumption amounts to 300 tuns. The scarcity of coal tar is the only thing which prevents M. Dehaynin from erecting other factories and increasing the manufacture of his compressed coal.

It will be observed that the railroad companies and the navy are using almost exclusively compressed coal, while private manufacturers do not seem to like it. The reason is that the burning of that coal produces such a smoke and such a bad smell that it is entirely unfit for domestic use, and cannot even be used in stationary engines, people in the neighborhood complaining of the nuisance. It was only permitted to be used in some sugar refineries and distilleries, situated at a reasonable distance from cities; and even then the law compelled the proprietors of those manufactures to raise their stacks to a specified hight.

So important has this subject of converting coal dust into lump coal been regarded, that the United States Commissioners, to the Paris exposition of 1867, have made a report on pressed or agglomerated coal, which presents the subject and its importance in an able and instructive manner.

That report sets down among the advantages attending the use of pressed coal, the following:

"Its purity and compactness adapts it to the rapid production of steam in furnaces and small fire grates, and it is, therefore, a desirable fuel for steamers and locomotives, for which it is largely used in Europe.

"Being manufactured in prismatic form, it can be very compactly stored on shipboard or elsewhere.

"It can readily be transported to great distances with very little waste, amounting, it is stated, to less than one tenth the waste of ordinary coal, handled under similar circumstances.

"It is not injured by frost, by snow, or by rain. Bricks of pressed coal produce as much steam in locomotives as an equal weight of coke. It is much liked by firemen, especially for raising steam in ascending heavy grades.

"Soft bituminous coal, or the mixture in which it predominates, is generally used in the manufacture of pressed coal."