Dec. 16, 1930. F. McINTYRE 1,785,386

METERING PUMP

Filed Sept. 8, 1927

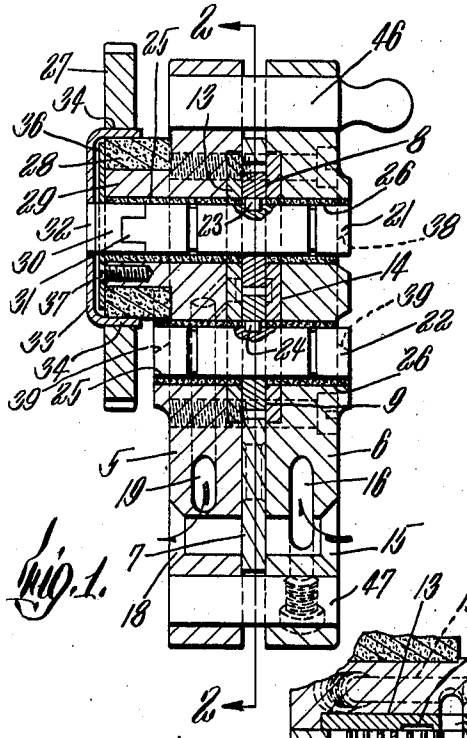


Fig. 1.

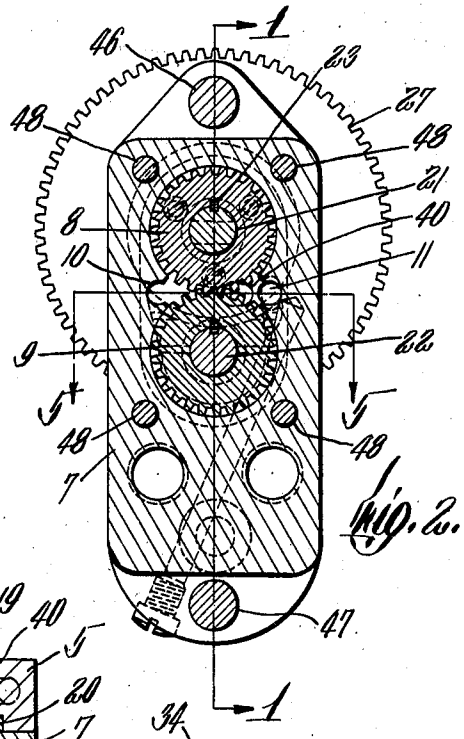


Fig. 2.

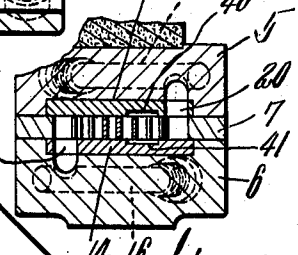


Fig. 5.

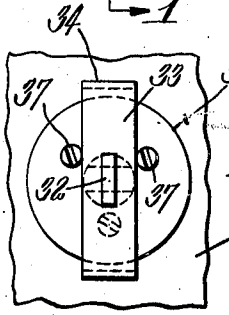


Fig. 3.

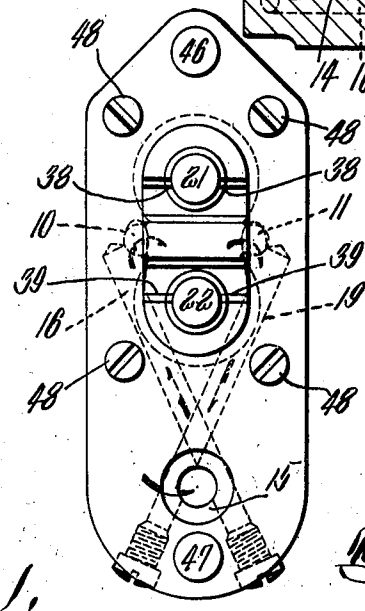


Fig. 4.

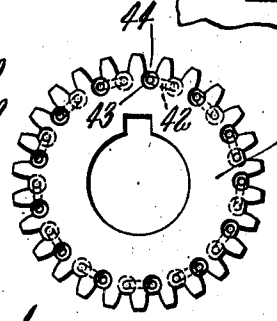


Fig. 6.

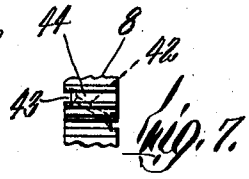


Fig. 7.

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UNITED STATES PATENT OFFICE

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METERING PUMP

Application filed September 8, 1927. Serial No. 218,340.

The present invention relates to metering pumps of the character used in the artificial silk industry to deliver regulated quantities of the solution of which artificial silk is made to the spinnerets or spinning-jets through which the solution is squirted to make filaments or strands. The main object of the invention is to produce a pump for this purpose, in the nature of a gear pump, which is free from the difficulties inherent in the metering pumps previously used and is capable of operating for long periods without sensible deterioration, and will deliver its output without appreciable variation during such periods, even though driven at very slow speeds, and without the need of making adjustments of any kind. In the accomplishment of this object, the fluid-propelling gears of the pump and the shafts on which they are mounted are fitted in the casing of the pump and to one another with great accuracy and minimum clearances, and in a manner such as substantially to eliminate wear between the rubbing surfaces of moving and stationary parts; preferably the several parts of the pump, or at least the surfaces thereof which come into contact with the solution are made of specially developed steels or iron alloys resistant to chemical action by the solution; the moving parts are adequately lubricated by the solution itself; provision is made for relieving the liquid entrapped between the closely fitting pump gears when they come into mesh; and means are provided for removing from the exposed ends of the shafts or arbors on which the pump gears are fitted the outflowing compound used for lubrication, in order to prevent sealing of the shaft bearings against such lubricating flow by accumulation of the dried and hardened compound.

In its principal characteristics, the embodiment of the invention here disclosed is identical with that shown in my prior application for Metering pump, filed October 29, 1926, Serial No. 145,092, and to the extent of all common subject matter, the present application is a continuation of that above identified. Additional new features are also described and claimed in this specification, as will later appear.

In the manufacture of artificial silk, commercially known as rayon, a cellulose compound or derivative, as nitrocellulose, viscose, cellulose acetate, or an analogous compound, transformed by solvents into a viscous liquid varying in viscosity according to the process used, is conducted by pipes, under pressure, to the spinning machines, and thence to small feed lines terminating at the spinnerets or spinning-jets. A metering pump is interposed in each of the feed lines in order to cause as nearly as possible uniform and equal amounts of the liquid to be supplied at adequate pressure to each of the spinnerets. The latter have minute holes of from two to five thousandths of an inch in diameter, each spinneret having as many such holes as there are filaments in each strand of the yarn to be produced. Filters are usually interposed in the feed lines between the pumps and the spinnerets to prevent passage of any minute particles which might clog the holes in the latter. These filters frequently become more or less stopped up and then cause so much resistance to flow of the solution as to build up a high back pressure, amounting sometimes to as much as 1000 pounds per square inch.

Uniformity in the highest possible degree is a prime essential of this product, the commercial price of which is determined largely by its uniformity of diameter. The generally accepted unit of finensss or coarseness of this yarn is the denier, which is the weight in frams of 9000 meters of yarn. That is, for instance, if 9000 meters of yarn weigh 100 grams, the yarn is graded as 100 denier. If the same amount weighs 50 grams, it is 50 denier yarn, etc. The use of yarns varying in denier in making fabrics gives an appearance of streaks of different shades, or causes other unsatisfactory results. Hence yarn of the greatest possible uniformity of denier commands a much higher price than uneven yarn.

To insure uniformity of the filaments of artificial silk, the liquid must be delivered to each spinneret at a uniform rate. It is a practical necessity also, in commercial prac-

tice where the spinning machines have from 30 to 100 spinnerets at each side, and a like number of pumps all driven from the same line shaft, to obtain equal delivery from all of such pumps. Each pump is in effect a meter as well as a means for delivering the liquid against back pressures which may increase considerably on account of clogged spinnerets or filters. Owing to the very small quantity of the liquid required to produce these strands, these pumps, even though they are of very small capacity, must be driven very slowly. For instance, a perfectly working gear pump of the capacity now generally accepted as a standard, when used for producing yarn of 50 denier, is driven at about 4½ revolutions per minute, and proportionally faster for yarns of larger counts. Of all the problems confronting the manufacturer of artificial silk, none has proved more vexatious than that of the indispensable metering pump. The difficult conditions under which they must work have heretofore caused rapid wear and deterioration of the pumps and have prevented continuous uniformity in their delivery during any considerable length of time.

The only lubrication that can be used in pumps of this kind is the solution itself from which the artificial silk is made, for the use of oil or other foreign matter as a lubricant would ruin the product. This material is a very poor lubricant, and in the pumps heretofore used, wherein no provision has been made for forced feed lubrication, has not been effective to prevent rapid wear of the parts. If the solution is allowed to dry and harden on rubbing surfaces, as will happen if the pump is left idle for even a short length of time, the hardened compound has a powerful abrasive action and will cut away the hardest steel enough to cause very serious impairment of accuracy within a few hours of running. Under the best conditions, gear pumps heretofore used have become enough worn within a few weeks to cause a substantial change in the rate of delivery and consequently an alteration in the diameter of the artificial silk filaments.

The effect of wear is usually a decrease in the rate of delivery of the pump. In the case of a gear type pump, the only mode of correcting such variation is to change the driving gear ratio, a time consuming and expensive operation at best, the limits of which are relatively narrow. That is, if the gears become too badly worn, even a considerable speeding up of the pump will not insure the required accuracy of delivery. On this account the plunger type of pump, with which adjustment can be made to increase the delivery without removing the pump from the pipe line, is more favored in practice than the gear type pump, even though it is more complicated. But in the factors of simplicity, the entire absence of pulsations, the greater accuracy with which it can be built, and ease of disassembling and cleaning (a necessary operation whenever the pump is compelled to remain idle for more than a few hours), the gear type pump is superior to the plunger type.

By my present invention I have produced a pump of the gear type having all the useful features of this type of pump with the further advantage that it is not subject to the necessity of adjustment as to its speed, because it possesses features which overcome and subsantially eliminate the tendency to wear, the bugbear of the gear pumps previously used in the artificial silk industry. I make use of the liquid compound for lubrication, but instead of confining the compound in the pump I provide means whereby it will flow continuously over the surfaces which require to be lubricated and thus insure constant renewal of the lubricant. In this connection I prefer to use bushings which have a very low coefficient of friction as bearings for the shafts on which the pump gears are mounted. This is one factor by which wear of rubbing parts is greatly diminished. Other factors consist in rigidly mounting such gears on extended shafts which are closely and accurately fitted in open ended bearings, whereby the gears are compelled to rotate in fixed locations with no peripheral rubbing and wear; by mounting the gear element through which power is applied to the pump gears in such a manner as to eliminate tendency to displace the shaft to which it is applied out of the prescribed alinement of such shaft; in, preferably, making provisions for relieving the liquid entrapped between the intermeshing teeth of the pump gears, but without doing so in such a way as will permit leakage and loss of pressure in the delivered fluid; in further reducing wear on the inner surfaces of the casings by inserting therein discs of very hard steel or other wear-resisting or anti-friction material at the parts which contact with the faces of the gears, or by plating the surfaces with a wear resisting metal, such as chromium, which is also resistant to chemical action; and in other particulars hereinafter described in detail.

Referring now to the drawings,—

Fig. 1 is a longitudinal section of a pump embodying this invention, the plane of section being indicated by line 1—1 of Fig. 2;

Fig. 2 is a longitudinal section on a plane at right angles to that on which the section of Fig. 1 is taken, and indicated by line 2—2 of Fig. 1;

Fig. 3 is a fragmentary elevation showing the exterior of the driving gear and the coupling between the same and the internal driven pump gear;

Fig. 4 is an elevation of the pump as seen from the right of Fig. 1;

Fig. 5 is a cross section on line 5—5 of Fig. 2;

Fig. 6 is a side view enlarged of a modified form of pump gear embodying means for relieving liquid entrapped between the intermeshing teeth of the complemental gears;

Fig. 7 is a fragmentary edgewise view of the gear shown in Fig. 6.

Like reference characters designate the same parts wherever they occur in all the figures.

The pump casing consists essentially of two relatively massive and rigid outer plates 5 and 6, preferably of cast iron, and an intermediate plate 7 of hardened steel. The contiguous faces of these plates are ground and finished (preferably by lapping) both flat and parallel within close limits of accuracy in order to make the joints between them leakage tight when the plates are assembled together. The intermediate plate is provided with circular transverse openings merging into one another, to receive and fit the gears 8 and 9 of the pump, and to provide ports or chambers 10 and 11 for the intake and outflow, respectively, of the fluid acted upon. Preferably also both side plates are recessed adjacent to the openings in the intermediate plate over an area somewhat greater than the total area of such openings, and wear plates 13 and 14 of hardened steel or other suitable material are fitted in such recesses overlapping the edges of the openings in the intermediate plate and providing surfaces adapted to reduce to the minimum the wear due to the rubbing action of the faces of such gears; the latter also being of hardened steel. The provision of such inserted wear plates is a useful feature where the side plates are made of cast iron, and is claimed as such; but it is not one of the essentials of the invention and may be omitted without departure therefrom, since highly satisfactory results in the attainment of long running life have been achieved with the cast iron side plates contiguous to the hardened steel gears. When the inserted wear plates are used, their exposed surfaces are finished, preferably by lapping, flush with the surfaces of the side plates into which they are sunk.

In the side plate 6 is an external port 15 from which an inclined passage 16 leads to the intake port or chamber 10, opening thereto through a passage 17, which extends through the inserted wear plate 14 also; and in the side plate 5 is a similar port 18 connected by passages 19 and 20 with the outlet port 11. Pipes for conducting the fluid to and away from the pump lead to the external ports 15 and 18 and are coupled thereto in a sufficiently leakage tight manner by means well known in the art and therefore not illustrated here. Conveniently such ports are made as passages extending entirely through the side plates and are closed off from one another by the intermediate plate, as shown in Fig. 1.

The pump gears 8 and 9 are fitted tightly upon shafts or arbors 21 and 22, which have their bearings in the side plates; and such gears may, if desired, be additionally secured non-rotatably to the shafts by means of keys 23 and 24, as here shown. The bearings for said shafts are preferably lined with bushings 25, 25 in the side plate 5, and 26, 26 in the side plate 6, made of material having a low coefficient of friction with steel, preferably metal impregnated with a large content of graphite, although other suitable materials may be used. Such nonfrictional bushings are also valuable, but not an absolutely essential feature, for highly satisfactory results in lubrication and long running life of the shafts can be and have been obtained without their use. The shafts and their bearings extend all the way through the side plates of the pump casing and open to the outer surfaces of such side plates, thereby affording outlets for escape and continuous flow of the artificial silk compound which is forced between the contiguous surfaces of the shafts and bearings by the action of the pump.

I include also as part of the invention, the use of alloy steels which are resistant to chemical attack by such artificial silk solutions as would corrode ordinary tool steel, for making the parts exposed to contact with the solution; and also the step of plating such parts with chromium or other metal resistant to the solution. The bearing bushings hereinbefore described are thus resistant. But shafts, gears and center plates made of tool steel which has been properly heat treated, and side plates of fine cast iron, give long and satisfactory service with the generally used solutions which do not corrode tool steel and cast iron.

Heretofore, in the gear pump used in this art, it has been the practice to mount the pump gears in a floating manner, whereby they are positioned and guided by engagement of their peripheries with the surrounding surfaces of the casing, and the pivots of the gears have been enclosed to prevent external leakage of the compound, and a stuffing box containing packing has been provided to surround the driving shaft for the same reason. In consequence, owing to the lack of provision for circulation of the compound between the wearing surfaces, the poor lubricating quality of the compound, its abrasive character when dried, and the limited area of bearing surfaces, the wear on the rubbing parts of such pumps has been rapid and great, with the evil consequences mentioned in the introductory part of this specification. My invention avoids these evil effects by preventing peripheral contact and wear of the pump gears and assuring forced lubrica-

tion by a continuous, minute and regulated flow of the compound between the gears and the bounding surfaces of the casing, and between the extended shafts and their open bearings.

The shafts locate the pump gears accurately, maintaining them in a plane parallel to the faces of the side plates and centering them in the chambers of the intermediate plate; thus preventing peripheral wear, which is most serious, and distributing the end or face wear of the gears. The shafts and bearings are made with a high quality of accuracy as to diameter with the minimum clearance required for lubrication. The gears likewise are made with the same accuracy of diameter and thickness and their teeth are cut as straight spur gear teeth by known precision methods to mesh together without backlash; so that the contacting teeth form gates effectually preventing flow between them from the delivery side to the inlet side. The outside circumferences of the gears, and the enveloping surfaces of the chambers in which they rotate, are made with just sufficient clearance to enable the gears to rotate, and insufficient clearance to permit loss of pressure by leakage of the viscous fluid around the gears, or passage of more than the small quantity, under pressure, needed for lubrication. In thickness, the gears are made slightly less than the intermediate plate 7 (the difference being in this case 2/10,000 of an inch, so that the clearance at each side of the gears is in the order of magnitude of 1/10,000 of an inch) and the faces of the gears are lapped flat and parallel and are maintained by their shafts parallel to the faces of the side plates 5 and 6, or of the inlaid wear plates 13 and 14. In the pumps that I have manufactured according to this invention, the clearances between the interior moving and stationary parts do not in any instance exceed 1/10,000 of an inch, and the tolerance to which the dimensions of the parts are held in manufacture is but a small fraction (about one-fourth) of this amount. By virtue thereof and of the manner in which the pump gears are mounted and controlled in rotation, there is no more leakage of the compound through the shaft bearings than the small controlled amount necessary for lubrication, and there is no loss of pressure in the delivered fluid, due to leakage between or around the gears, notwithstanding the very slow rate at which the gears are rotated in practice. But the small clearances mentioned allow enough of the liquid, under the heavy pressure imposed by the pump, to flow between the surfaces of the moving parts and the adjacent bearing surfaces, with a continuous slow movement which prevents stagnation and drying of the liquid between these surfaces. There are no stuffing boxes or packings around any of the shafts whereby the difficulties due to the compound working into the packings and there solidifying are avoided.

An external gear 27 is coupled to one of the shafts, as 21, for driving the pump gear 8, the latter in turn driving the pump gear 9 by their intermeshing teeth. Gear 27 is applied and made fast to a hub 28, made of metal impregnated with graphite, and fitted to rotate about an external bearing boss 29 on the plate 5 coaxial with the bearing of shaft 21. Owing to the graphite with which the hub 28 is impregnated, lubrication of this hub is not required. Connection between the gear 27 and shaft 21 is made by a coupling 30 fitting rotatably in the shaft bearing and having in its inner end a central transverse slot which receives a tongue 31 on the shaft, and having on its outer end a tongue 32 in a central diametral plane at right angles to that of said slot and entering a complemental slot in a key strap 33. This key strap crosses the end of the coupling and its ends 34 are bent over and pass through the gear and are spread or headed over against the rear side of the latter. The gear is retained on the bearing boss 29 by a plate 36 which is secured by screws 37 to the end of the boss and overlaps the hub portion of the gear. A hole in the central part of this plate receives the coupling 30. Thus the driving gear is mounted to turn upon its own rigid bearing but is flexibly connected to the pump gear shaft 21 so that it applies only rotational force to the shaft and has no tendency to deflect the shaft and the pump gear mounted on the latter. Such flexible connection is obtained by the coupling 30 which is adapted to shift laterally in directions at right angles to its axis with respect to the driving gear 27 and the shaft 21. By virtue of this capability it will transmit rotation to the shaft without tendency to deflect the shaft laterally even though the bearing for the gear may be more or less eccentric to the axis of the shaft. Its connection by means of tongues and grooves or slots at right angles to one another enables the coupling to shift laterally in any direction with respect to the shaft.

I have provided scrapers or cutters to remove the compound as it exudes from the ends of the shaft bearings, so as to prevent the accumulation of the dried compound over the ends of the shafts and blocking of the bearings thereby. In the illustrated instance, such cutting or scraping means are provided by forming a boss on the outer side of the casing, and cutting channels in such boss so as to remove the bearing about approximately one half of the circumference of the shaft extremity, similarly cutting away the bearing bushings or liners where such are used. Thereby shoulders 38, 39 are formed flanking and closely embracing the protruding extremities of the

shafts, which shoulders wipe and scrape the surfaces of the shafts, removing the compound as it flows out of the bearings and preventing it from drying and accumulating. Thus outlets are kept open for escape of the compound. I have shown such scraping or cutting means in these drawings at the outer sides of both casing plates adjacent to the ends of shaft 22, and on the plate 6 at one end of shaft 21. As to the other end of shaft 21, or rather the outer end of the coupling section 30, the key strap 33 performs the same office by constantly scraping off the liquid oozing from the extension of the bearing within the boss 29.

I have made provisions also for relieving, or permitting escape of, the liquid entrapped between intermeshing teeth of the pump gears when these teeth come into mesh. Each tooth of one gear, entering the conjugate tooth space of the other, makes tangent contact with the flanking teeth of such space before it has penetrated to the full extent into the space. The liquid in the space is thus entrapped and, owing to the close fit of the gears in their chambers and the absence of backlash between the gears, cannot escape except through the minute clearances between the faces of the gears and the enveloping surfaces of the pump casing. Without provision for its relief, excessive pressure would be imposed on the entrapped liquid by further penetration of the gear teeth, and this pressure would be transferred to the shaft bearings. In order to relieve such pressure and avoid injurious effects liable to follow therefrom, I have made provisions for escape of the liquid thus entrapped. One form of such provisions is shown in Figs. 2 and 5, and consists in cavities 40, 41, in the adjacent faces of the pump casing plates or the inlaid wear plates therein, such cavities opening into the chamber from which the delivery outlet leads and extending in the direction of common rotation of the gears to approximately or nearly the point where the teeth have made full penetration into the conjugate tooth spaces. But they do not extend far enough to afford a bypassage through which fluid could flow from the delivery side under the higher pressure which exists at that side to the inlet side where the pressure is lower. On the contrary, the cavities terminate at such a point that the gear teeth, after passing them, remain in contact with one another to serve as gates to prevent back flow; and preferably also they terminate short of the point where the teeth have made fullest penetration, so that pressure will still be imposed, independently of the back pressure, on the entrapped liquid sufficient to force it for lubrication into the bearing clearances.

An alternate means for thus relieving the entrapped liquid is shown in Figs. 6 and 7 and consists in forming each gear with inclined channels 42, each of which leads from a chamber 43 in one face of the gear and opening through a gateway 44 into a tooth space, such channel leading thence in an inclined direction to a similar chamber in the opposite face of the gear opening into the next tooth space. Thus the liquid entrapped in one space is able to flow through the next following space to the delivery chamber before the following space has been closed by an entering tooth. In each gear these channels communicate with alternate tooth spaces in the same face of the gear, and the two conjugate gears of the pump are so arranged that the intermediate spaces are relieved by similar channels in the other gear.

The outer plates 5 and 6 of the casing are alined with one another by massive rods or dowels 46 and 47 fixed in the plate 6 and extending removably, but with a tight fit, in alined holes in the plate 5; or vice versa. These dowels and the holes in which they fit are parallel to the shaft bearings and are in the same plane therewith, as shown by the line 1—1 in Fig. 2. They aline the bearings in the two plates when the parts of the pump are assembled together, relieving the shafts of the duty of preserving such alinement. Screws 48 are passed through one of the plates and threaded into tapped holes in the other for the purpose of drawing the plates together and making the joints between the outer and intermediate plates leakage tight, but they are not depended on to obtain or maintain the alinement of the bearings. The arrangement of the four passages for the dowels and shaft bearings in the same plane simplifies the task of accurately locating and finishing these passages so that they will fit the dowels and shafts and, when assembled, will provide the proper clearance for the shafts and bearings in both outer plates. As here shown, the ends of the outer plates extend beyond the ends of the intermediate plate, and the passages for the dowels are in such extensions.

All the parts of the pump hereinbefore described, except the provisions for relief of entrapped fluid between the teeth of the pump gears, the provisions for cutting away the compound from the ends of the shafts, the inserted wear plates, and the corrosion-resisting plating or composition, are identical with the disclosure of my prior application, Serial No. 145,092, hereinbefore identified, and to that extent the present application is a continuation of the prior one.

The pumps which I have made in accordance with this invention and put to use have shown no perceptible wear and no perceptible variation in their delivery rate after many months of service, and different individual pumps so made and designed to have the same capacity, show less than two per cent variation from one another when run at the same

speed. Such variation is negligible for the purposes of the artificial silk industry. The rate of delivery of these pumps is directly proportional to the speed at which they are driven. In use they are free from the difficulties of operation and the expense of testing and adjustment which have been the bugbear of the artificial silk industry heretofore.

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

1. A metering pump for delivering fluid cellulose compound to be spun into artificial silk comprising a casing having interior circular chambers for the reception of pump gears and inlet and outlet passages to and from such chambers, straight spur gears located in said chambers, and rotatable shafts on which said gears are mounted and rigidly fixed, having bearings in the casing, said bearings extending and opening to the exterior of the casing and providing channels for the flow from said chambers past the gears and shafts of a controlled quantity of the fluid being pumped, for lubrication.

2. A metering pump for delivering liquid cellulose compound to be spun into artificial silk comprising a casing formed of outer plates and an intermediate plate secured together with leakage tight contact between the contiguous surfaces of said plates, the intermediate plate having communicating gear chambers, and the outer plates forming bounding end walls of said chambers and having passages for inflow and discharge of the solution, pump gears substantially filling such chambers and having straight spur teeth intermeshing with one another without backlash, rotatable shafts passing through said gears and to which the respective gears are rigidly secured, the outer plates having bearings for said shafts arranged coaxially with the respective chambers, whereby to center the gears in said chambers and hold the ends of the teeth out of contact with the encircling walls of said chambers, the gears being fitted to said chambers and the shafts to said bearings with clearances of an order of magnitude of one ten-thousandth of an inch, thereby preventing leakage of the liquid being pumped except a controlled small amount sufficient for lubrication, and the bearings extending to the outer sides of the casing to permit continuous flow of said liquid when the pump is in operation.

3. A metering pump for delivering fluid cellulose compound to be spun into artificial silk comprising a casing having interior gear chambers and shaft bearings extending to the outside of the casing, shafts fitted to said bearings, and intermeshing pump gears fitted to said chambers and rigidly mounted on their respective shafts, said gears and shafts being fitted to their respective chambers and bearings so closely as to prevent leakage except for a small controlled amount sufficient for lubrication, and means at the exterior of the casing adjacent to the extremities of the shafts for removing therefrom the exuded compound.

4. A gear pump comprising a casing having gear cavities with inlet and outlet passages, intermeshing pump gears mounted within said cavities, shafts for both gears rotatably mounted and concentrically arranged with respect to said gears and cavities and upon which said gears are secured, said shafts both having their bearings in the casing at both sides of the gears and the bearings therefor being open externally of the casing, a driving element mounted on an independent bearing surrounding the axis of one of the shafts, and a coupling between said shaft and driving element constructed to transmit rotation to said shaft and yieldable under pressure in all directions laterally thereof.

5. A gear pump comprising a casing, intermeshing pump gears rotatably arranged in said casing, shafts concentric with the respective gears to which the latter are secured and having bearings in the casing, a driving element independently mounted rotatably on the casing surrounding the axis of one of said shafts, a coupling between said element and shaft comprising a member having a tongue at one end and a slot at the other end, the shaft having a tongue on its end which enters said slot, and a key member secured to the driving element and having a slot in which the tongue of said coupling member is received.

6. A gear pump comprising outer plates and an intermediate plate, forming a casing, parallel shaft bearings extending through both outer plates, those in one plate being alined with the corresponding bearings in the other, and gear chambers in the intermediate plate coaxial with the respective shaft bearings, intermeshing pump gears fitted to said chambers, shafts fitted to rotate in said bearings passing through the same and the chambers and the gears and being rigidly secured to the latter, one of the outer plates having an external bearing surrounding the axis of one of the shaft bearings, a driving element rotatably mounted on said external bearing, a coupling piece having a tongue and slot engagement with the adjacent end of the shaft in the last named shaft bearing, and a key piece secured to the driving element crossing the last named bearing and having a tongue and slot engagement with the coupling piece extending transversely to the first named tongue and slot engagement.

7. A metering pump for delivering artificial silk solution comprising side plates and an intermediate plate combined to form a casing, the intermediate plate having chambers for pump gears and the side plates having shaft bearings coaxial with said chambers and passages leading to and from the inlet and outlet sides, respectively, of said cham-

bers, and wear plates inlaid in said side plates adjacent to the intermediate plate, extending across the chambers in the latter and forming end walls for said chambers.

8. A metering pump for delivering artificial silk solution comprising side plates and an intermediate plate combined to form a casing, the intermediate plate having chambers for pump gears and the side plates having shaft bearings coaxial with said chambers and passages leading to and from the inlet and outlet sides, respectively, of said chambers, intermeshing pump gears fitting rotatably within said chambers, shafts fitting rotatably in said bearings on which the respective pump gears are mounted, and wear plates inlaid in the side plates arranged to extend across and form the bounding end walls of said chambers; the gears being fitted in said chambers with clearances sufficient only to permit a controlled flow of the solution for lubrication but insufficient to permit loss of pressure in the delivered fluid by leakage, and one of the wear plates having a cavity communicating with the delivery side of the pump and with the area traversed by the teeth of the gear when coming into mesh.

9. A metering pump for delivering artificial silk solution comprising side plates and an intermediate platc combined to form a casing, the intermediate plate having chambers for pump gears and the side plates having shaft bearings coaxial with said chambers and passages leading to and from the inlet and outlet sides, respectively, of said chambers, said bearings extending to the outer side of the side plates, intermeshing pump gears fitted rotatably in said chambers and shafts on which said gears are rigidly mounted fitted rotatably in said bearings and extending substantially to the outer ends thereof, the side plates having scraping shoulders beside the outer ends of the shafts arranged to remove the solution oozing from the shaft bearings.

10. A metering pump for delivering solution to be spun into artificial silk comprising a casing having interior pump gear chambers, inlet and delivery passages for the solution and shaft bearings concentric with said chambers and opened externally of the casing, intermeshing pump gears and associated shafts fitted rotatably in said chambers and bearings, respectively, with clearance sufficient only for forced flow of a lubricating film of the solution and insufficient to permit loss of pressure, said shafts extending to the outside of the casing, and the casing having scraping means engaging the sides of the shafts adjacent to their outer ends and arranged to dislodge the solution oozing from the bearings.

11. A gear pump comprising a casing having merging gear cavities with inlet and outlet passages, intermeshing pump gears fitted rotatably within said cavities, shafts on which said gears are mounted having bearings in the casing, a driving element rotatably mounted on an independent bearing surrounding the axis of one of the shafts externally of the casing, and coupling means between said element and the last named shaft constructed to transmit rotation from the driving element to the shaft while being yieldable under lateral pressure in all directions in a plane transverse to the shaft.

In testimony whereof I have affixed my signature.

FREDERIC McINTYRE.