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SUSPENSIONS BY COLD MIXING

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Cold mixing is probably defined most frequently as a "process by which fluid fertilizers are made of raw materials which release little or no heat when they are mixed." The cold mixing of clear liquids is a well established process, used at one time or another by over half the manufacturers in the fluid fertilizer industry.

To produce suspensions by cold mixing, one of the liquid base solutions such as 10-34-0, 11-37-0, or 12-40-0 is mixed with clay, urea-ammonium nitrate, and potash to make high-analysis suspensions such as 20-10-10, 10-30-10, 15-15-15, 18-9-18, and 7-21-21. It is also possible to suspend the correct amounts of micronutrients and, in many plants, to incorporate herbicides and insecticides in suspension mixtures. A recent survey shows that about 90 percent of the suspension fertilizers produced in 1967 were made by the cold-mix process. Average analysis of these suspensions was about 42 percent higher than that of comparable clear-liquid mixtures. The survey also shows that about twice as many plants will use the cold-mix process this year as in 1967.

Plant Description

Figure 1 is a sketch of a typical cold-mix plant. The estimated cost of such a plant is about $25,000. Potash is screened by a small oscillating 8-mesh screen. This screen is necessary for the removal of oversize potash and any foreign material. Although the amount of foreign material is small, it will cause application difficulty unless it is removed. Usually the quantity of oversize potash is so small that it can be hand-crushed and rescreened. However, some operators permit it to discharge into a barrel of water where it forms a saturated solution of potash which can be used to replace some of the water in the formulation.

Most suspension manufacturers add clay by using a small separate handling system which consists of a clay hopper and a small screw conveyor. Clay is also added by pouring from an open bag into the mix tank. When this is done, care should be taken to dribble clay into the liquid at a rate of about 50 pounds every 2 minutes. If a full bag is dumped at one time, the clay is likely to form large balls and be difficult to disperse and gel. Sometimes a clay injector such as that shown in Figure 2 is used. This injector has a venturi section through which the suspension is recirculated. A clay hopper is also welded to the top of the venturi section, and clay is drawn into the recirculating suspension and thus into the mixture.

Figure 3 is a sketch of a typical mix tank which has been converted to a batch mix tank for suspensions. The tank should have a cone bottom so that settled solids can be easily recirculated for dispersion in the suspension. It should be equipped with a large agitator and a recirculation pump for violent agitation. The agitator shown in this sketch is fabricated from a used truck transmission and the rear end of a truck which serves as a speed reducer. The turbine can be built in a small shop. Many companies sell properly designed agitators.

It is recommended that the suspension be strained as it is pumped to and from storage.

Figure 4 is a sketch of an air sparger which should be installed in the product storage tank. The sparger is fabricated from rubber hose or soft plastic tubing, and small slits are cut in its upper surface. Under pressure the slits open and permit the passage of air which agitates the suspension. When air pressure is cut off, the slits close and do not become clogged with the suspension. A suspension in storage should be agitated for 15 minutes once every 12 hours.

Satellite Plant

A cold-mix plant serving satellite stations is another type of the suspension marketing system. Figure 5 is a sketch of a typical satellite station. In such a station desired quantities of 12-40-0, 5-15-30, and 32-0-0 are weighed in the nurse tank into which air is sparged to provide agitation. Some satellite station operators have installed a small mix tank, mounted on scales, in which the suspensions are weighed and mixed by recirculation.

The estimated investment cost of a satellite station is about $9,000. Each liquid cold-mix plant should be able to service at least 15 stations. Figure 6 is a diagram of such a marketing system. Total investment should be considerably less than the investment in a conventional cold-mix plant in the same location and substantially less than the investment in a system for the bulk blending of solid materials. Because of the tendency of materials in bulk blends to segregate, it is extremely difficult for a bulk-blending plant to have satellite stations in which blends can be stored and handled.

Materials Used in Cold Mixing

Several companies have used 10-34-0 and 11-37-0 clear liquids in the production of suspension mixtures. They have found the following mixing procedure to be satisfactory:

1. First add to the mix tank water and enough urea-ammonium nitrate solution for the clay content of the mixture not to exceed about 12 percent clay.

2. Next add clay and allow it to gel about 5 to 7 minutes.

3. Add 10-34-0 or 11-37-0 liquid.

4. Add potash.

5. Add the rest of the urea-ammonium nitrate solution required by the formulation.

Recent small-scale tests indicate that when possible the urea-ammonium nitrate solution should be added after the potash has been added and mixed for a period of time. When this procedure is used, the potash in solution reacts with the nitrate of urea-ammonium nitrate solution and saturates the suspension with very small potassium nitrate crystals. Such saturation with small crystals helps prevent the growth of large crystals in the suspension.

Several companies are successfully using 12-40-0 ammonium polyphosphate solution to produce suspensions by cold mixing. Base suspension can be made from either wet-process or furnace superphosphoric acid. TVA has recently developed a process for the direct production of ammonium polyphosphate base suspension from wet-process orthophosphoric acid which contains 54 percent P_2O_5. Advantages in using a base suspension are:

1. Little or no additional suspending clay is needed in the mixture. Therefore, the handling of clay and the time required to gel it can be kept to a minimum.

2. A base grade with an analysis about 20 percent higher than that of a comparable clear liquid can be shipped as a suspension. Therefore, freight and handling cost can be lowered.

3. Higher grades can be produced from base suspension (such as 12-40-0) than from base solutions (10-34-0 and 11-37-0).

A solid ammonium polyphosphate (15-61-0) is being tested in the TVA field program for the production of suspensions. This material is granular and free-flowing, and 50 percent of its phosphate is in the polyphosphate form. Ammonium polyphosphate can be easily solubilized. It has been used to produce clear liquid grades such as 10-34-0, 7-21-7, 8-8-8, and 5-10-10. When it is used in the production of suspensions, the same mixing procedure outlined for the use of 10-34-0 and 11-37-0 is followed. Suspension grades such as 5-15-30, 7-21-21, and 13-13-13 have been produced with either potash or potassium sulfate.

One company has used ammonium polyphosphate and dilute spent phosphoric acid or wet-process orthophosphoric acid in the production of suspension grades. Grades such as 5-15-30, 10-10-18, and 7-21-21 have been produced. Fifty percent of the P_2O_5 was supplied as spent phosphoric acid and 50 percent as ammonium polyphosphate. By definition this operation is not a true cold-mix procedure. However, it is a modified cold-mix operation, because no cooler is required and at the end of the mixing cycle the mixture is about at room temperature. Ammonium polyphosphate and potash have negative heats of solution which about offset the heat released by the reaction of the spent acid and aqua ammonia.

There were indications last spring that diammonium phosphate and urea were selling at very low prices. These materials can be easily used in suspensions. Advantages of their depressed prices can be realized by cold-mix plants in the fluid fertilizer industry.

Diammonium phosphate (18-46-0) has been used in combination with 15-61-0 solid ammonium polyphosphate to produce an 8-24-8 suspension grade. When the two are mixed, they adjust each other to the $N:P_2O_5$ ratio of maximum solubility. Because both materials are of high analysis, rather large quantities of water can be used in the formulation. The resulting suspension still has a high plant-nutrient concentration. The mixing procedure is:

1. Add water.
2. Add clay and allow to gel.
3. Add 18-46-0.
4. Mix 5 minutes to partially dissolve the 18-46-0.
5. Add 15-61-0 and mix 15 minutes to completely dissolve all solids.
6. Add potash.
7. Add urea-ammonium nitrate solution.

Tests have shown that in early spring a plant that has stored 28-0-0 solution through the winter can produce a good high-nitrogen suspension (37 to 38 percent nitrogen) by cold mixing the 28-0-0 solution with conditioned microprills of urea.

New Materials

TVA is developing several new processes for the production of high-analysis base suspensions. In one process a 14-44-0 suspension will be formed by the neutralization of superphosphoric acid with ammonia. In some situations it should be possible to produce mixtures of higher analyses with this material.

In another process a high-analysis urea-ammonium nitrate suspension which has a nitrogen content of 37 percent is produced. This material has been field-tested, and we have had excellent results in producing from it suspensions such as 30-10-0 and 16-16-16. However, the 37 percent nitrogen suspension does not store well during the winter. Studies are being made in an effort to improve its winter storage characteristics.

Recent tests show also that sodium bentonite clay is as effective a suspending agent as attapulgite clay, provided the clay is gelled in water. Deposits of sodium bentonite clay have been found in Wyoming. Work is continuing in an effort to find other gelling agents.

A limited quantity of a 12-40-0-2S was produced at TVA last spring from anhydrous ammonia-sulfur solution (74 percent N and 10 percent S) and superphosphoric acid. In its production, elemental sulfur was first dissolved in anhydrous ammonia, and superphosphoric acid was neutralized with the resulting solution. Sulfur released into the suspension was very fine (about 10 microns). Agronomic tests are being conducted with this suspension. It is reasonable to assume that the sulfur will be converted to an agronomically available form soon after it is applied because of its fine size.

TVA also introduced into its field programs a 14-59-0-4Zn solid ammonium polyphosphate which was used as a zinc source for fluid fertilizers.

Application Equipment

There are several noncomplicated types of equipment for broadcasting suspensions. Figure 7 is a sketch of a truck equipped to recirculate suspensions through a sparger to keep the materials suspended. The sparger is located at the 8 o'clock or the 4 o'clock position, and the holes are directed so that the recirculating suspension sweeps the bottom of the tank.

Another type of truck for broadcasting suspensions is shown in Figure 8. A rubber hose-type air sparger with slits cut in the upper surface is used to agitate the liquid in this applicator. Neither applicator has a boom, but one or more nozzles are installed at the rear end of each truck. Application rate is changed by variations in the speed of the truck and the number and the height of the nozzles.

Figure 9 is a sketch of a conventional corn planter which can be adapted for row application of suspensions. This attachment usually consists of supply tanks which normally come with the liquid attachment and a hose pump which operates on the principle of squeezing a liquid through a compressible tube. (These tanks, however, can be replaced with a single tank.) As the reel turns, the rollers on the reel flatten the tubes and force fertilizer through the hose and knife tube. Farmers have used some of the piston-type metering pumps to inject suspensions. These pumps should be altered so that they can withstand abrasion by suspensions, and their valves should be designed so that they do not become clogged with crystals.

Suspension fertilizers appear to be here to stay. One of the simplest and least expensive ways to produce suspensions is by cold mixing.

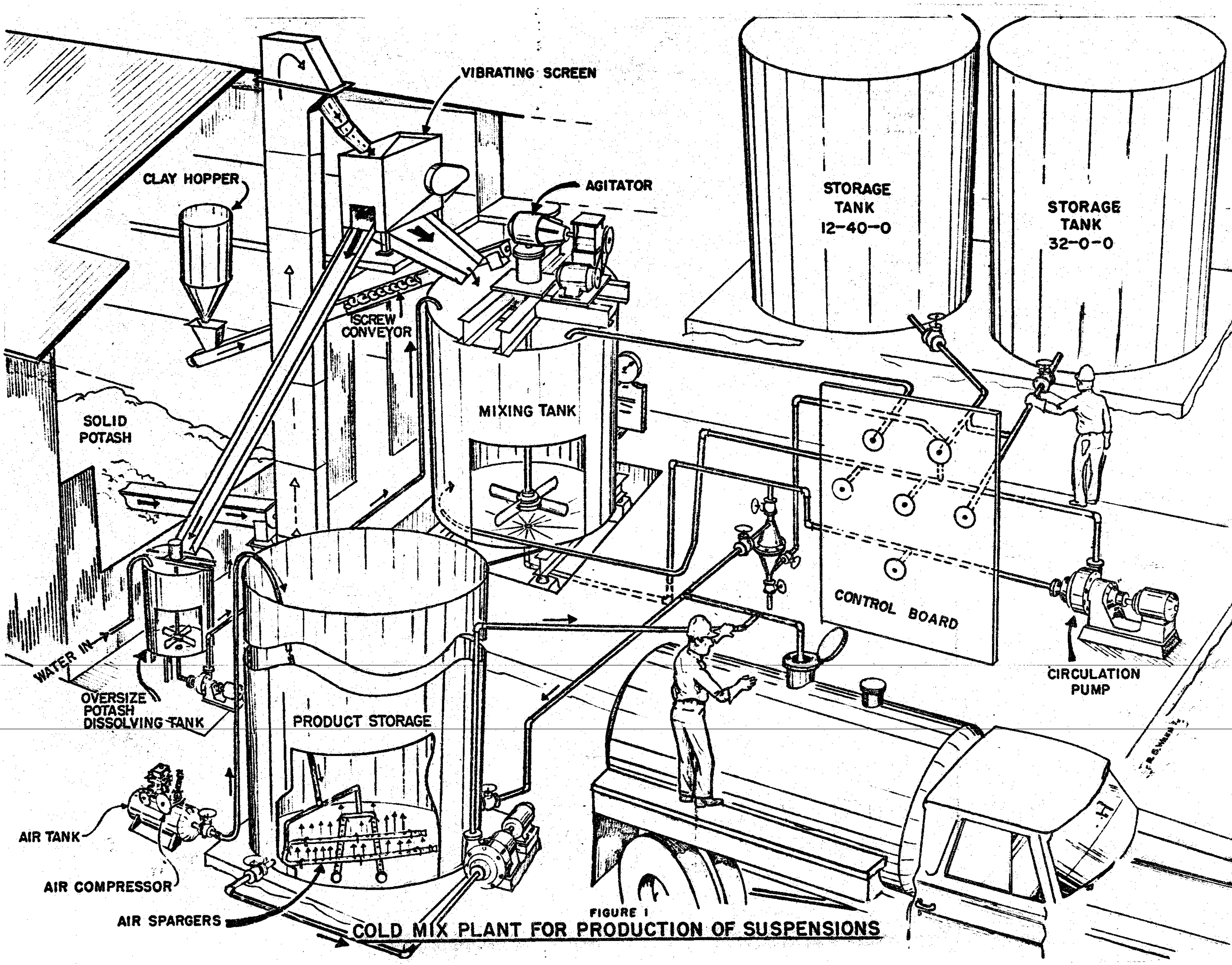


FIGURE I

COLD MIX PLANT FOR PRODUCTION OF SUSPENSIONS

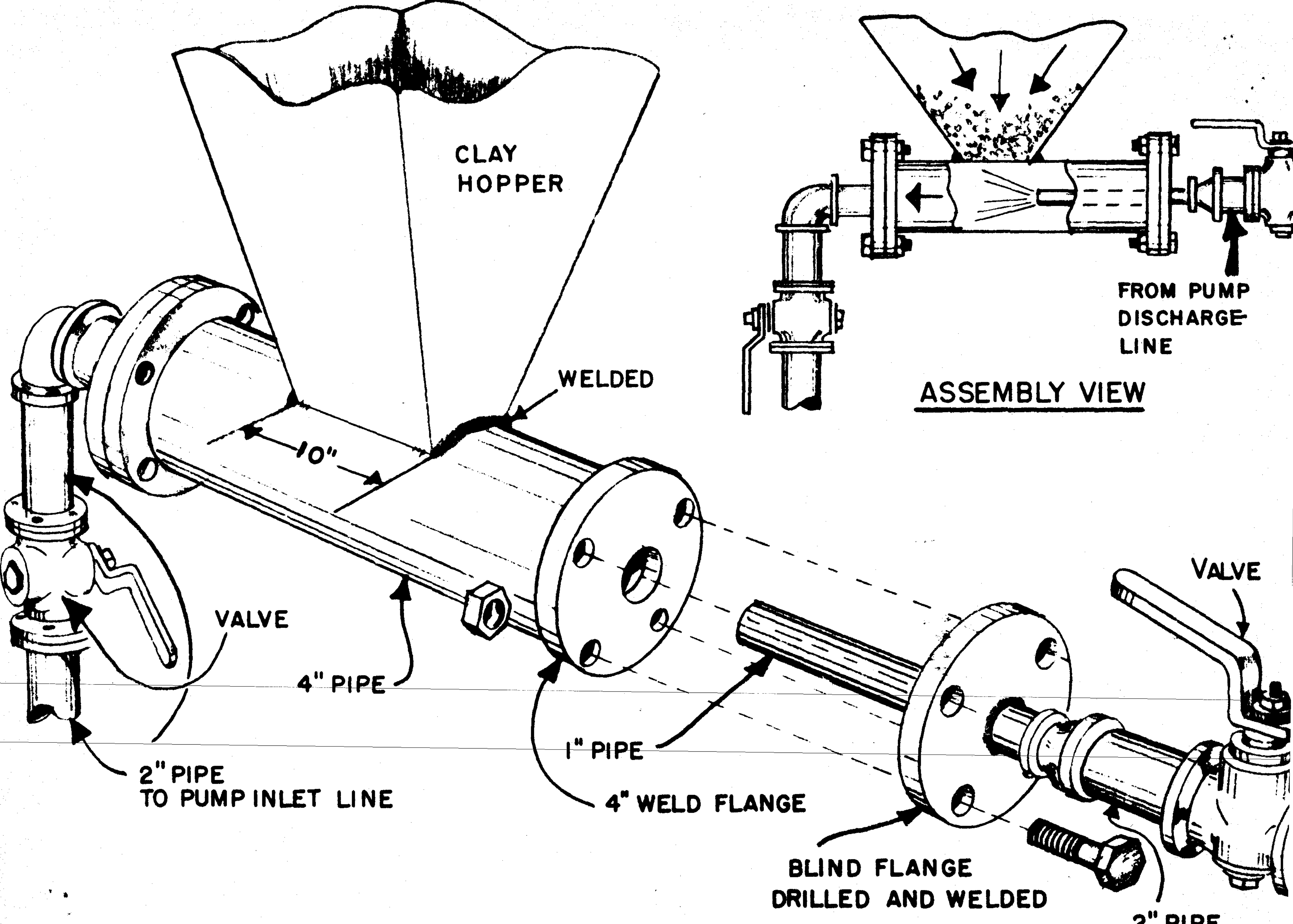


Figure 2

CLAY INJECTOR FOR SUSPENSIONS

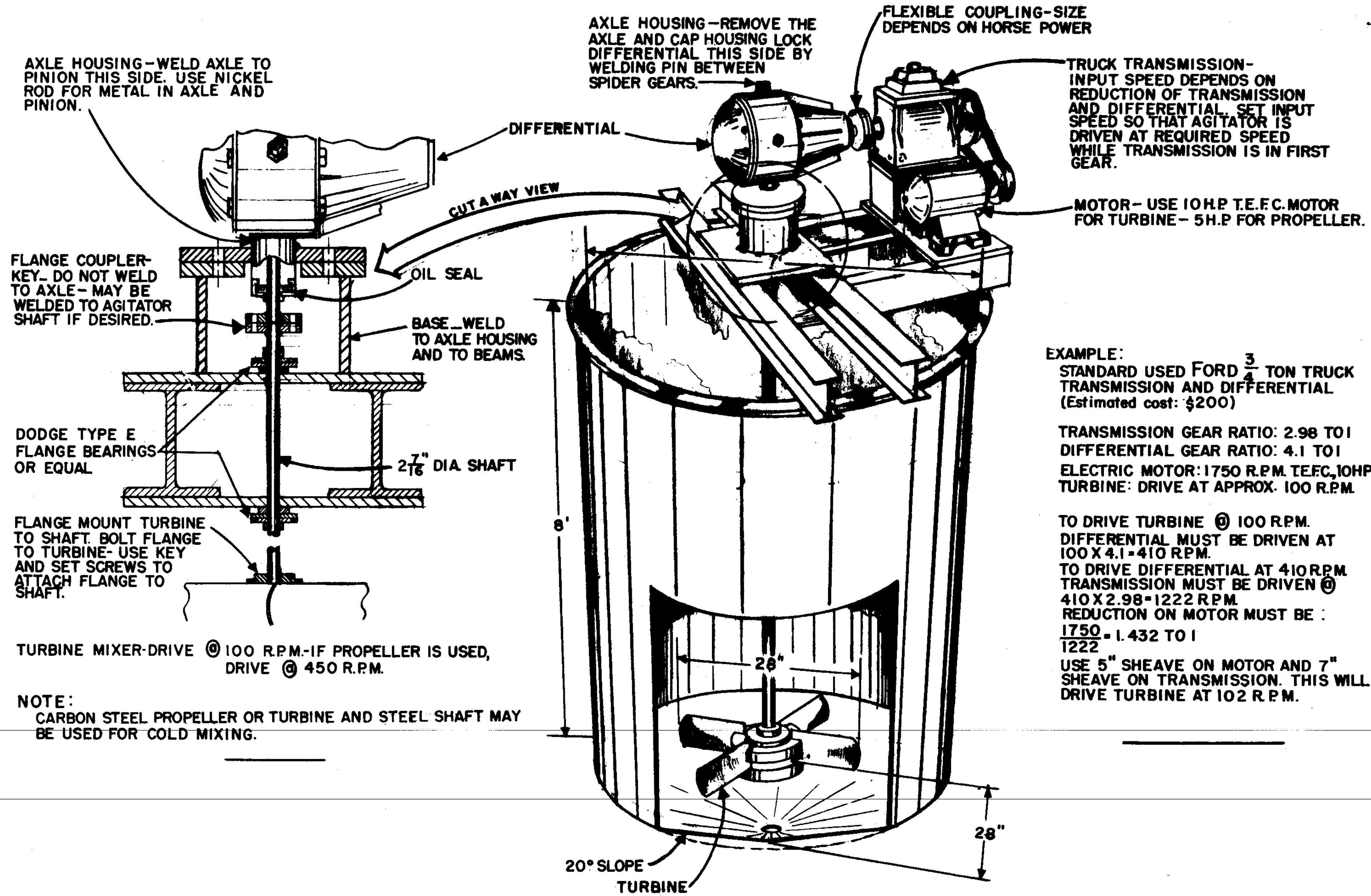
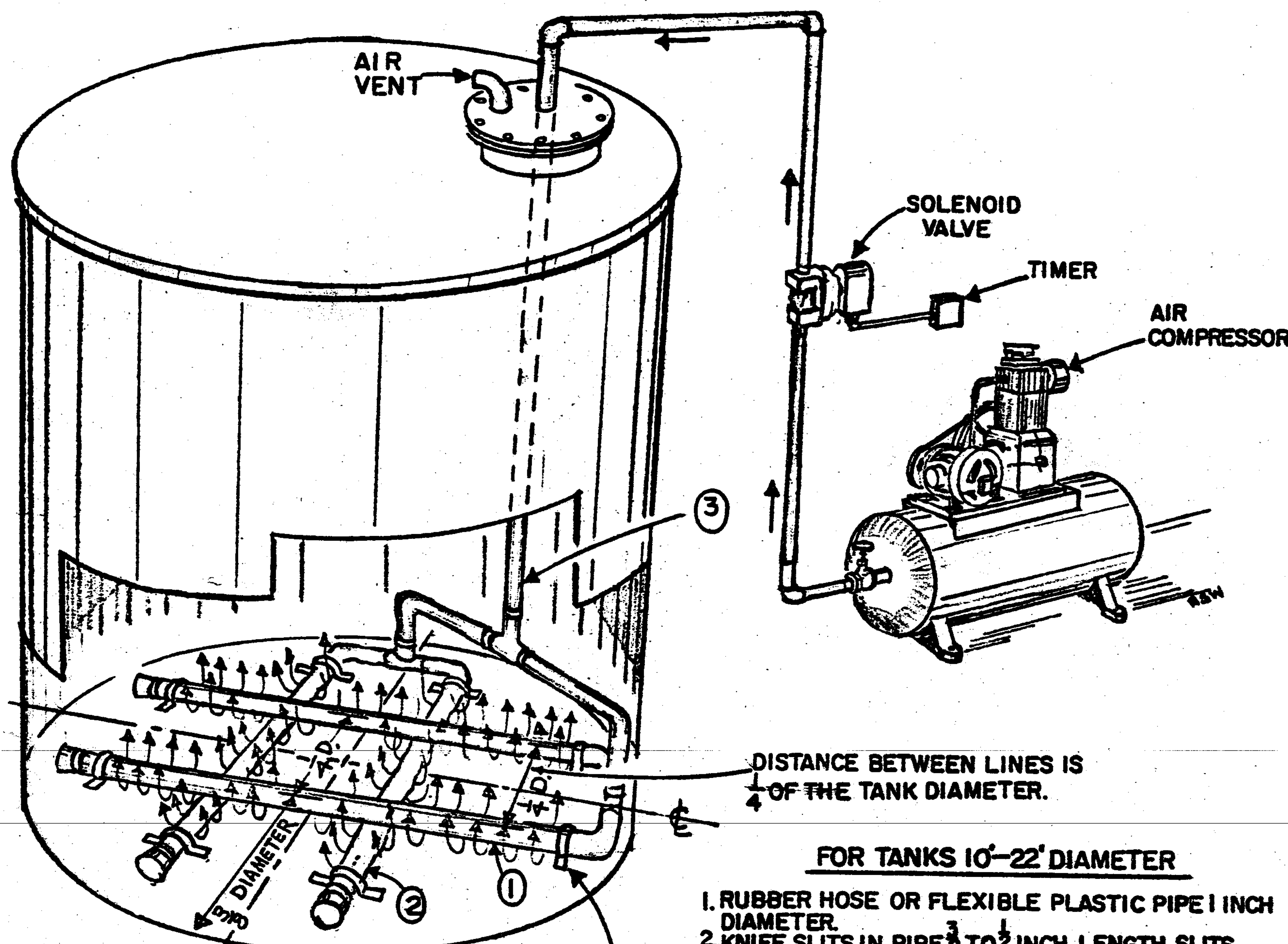


FIGURE 3

AGITATOR MADE FROM TRUCK DIFFERENTIAL AND TRANSMISSION



FOR TANKS 10'–22' DIAMETER

1. RUBBER HOSE OR FLEXIBLE PLASTIC PIPE 1 INCH DIAMETER.
2. KNIFE SLITS IN PIPE $\frac{3}{8}$ TO $\frac{1}{2}$ INCH LENGTH, SLITS SPACED ABOUT 2 INCHES APART. POINT SLITS DOWNWARD.
3. STEEL OR RIGID PLASTIC PIPES PLACED PERPENDICULAR AS SHOWN IN THE SKETCH.
4. TO HOLD PIPES IN POSITION, TIE AT CROSSOVER AND WEIGH WITH METAL AROUND PIPE.
5. INSTALL AIR VENT IN MANHOL COVER.

FIG. 4
AIR SPARGER

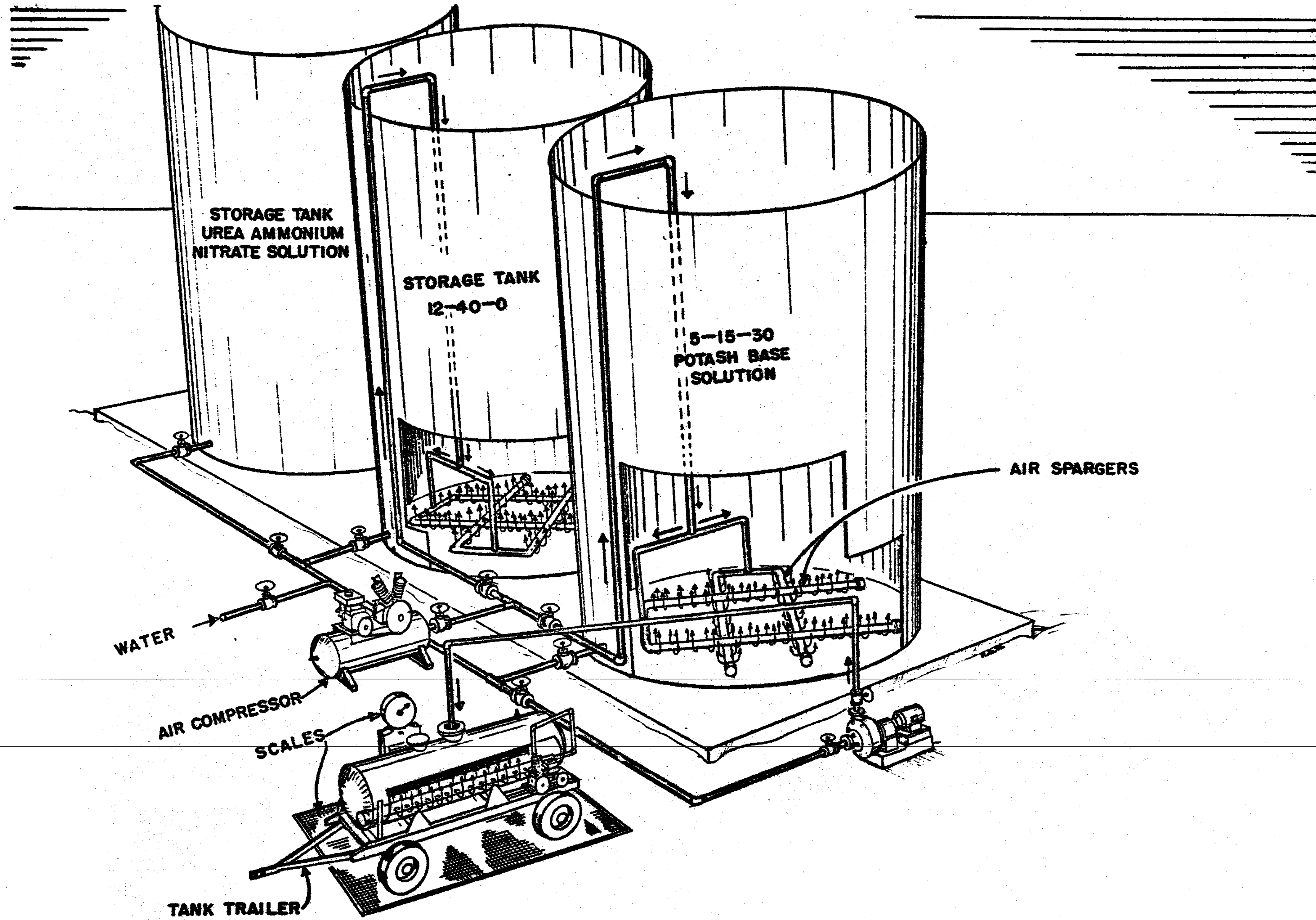


FIGURE 5

SATELLITE COLD BLENDING SUSPENSION STATION

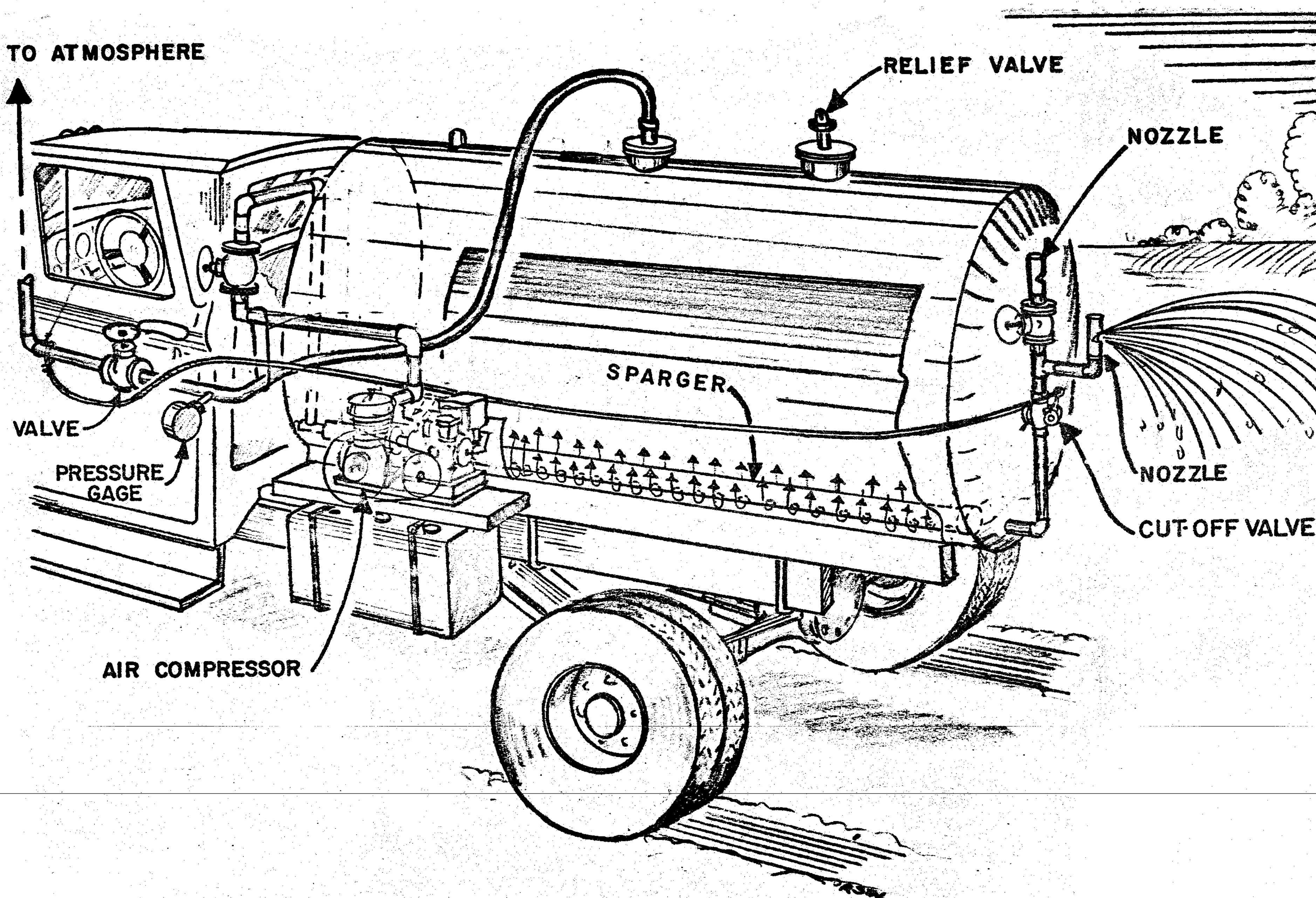


FIGURE 8

APPLICATOR FOR SUSPENSION FERTILIZERS

(AIR SPARGER WITH TWO NOZZLES)

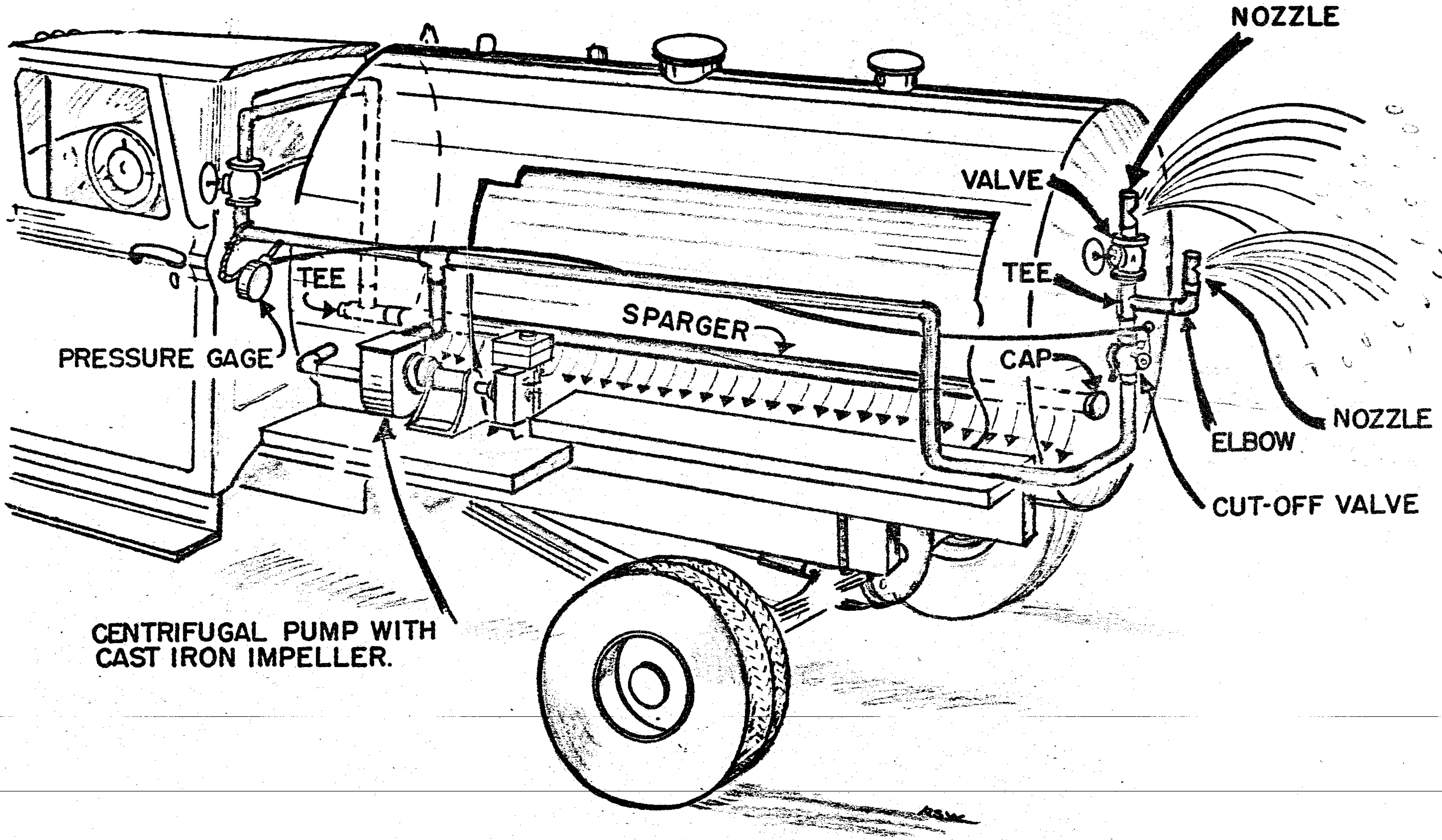


FIGURE 7
APPLICATOR FOR SUSPENSION FERTILIZERS
(PUMP WITH SPARGER AND TWO SPRAY NOZZLES)

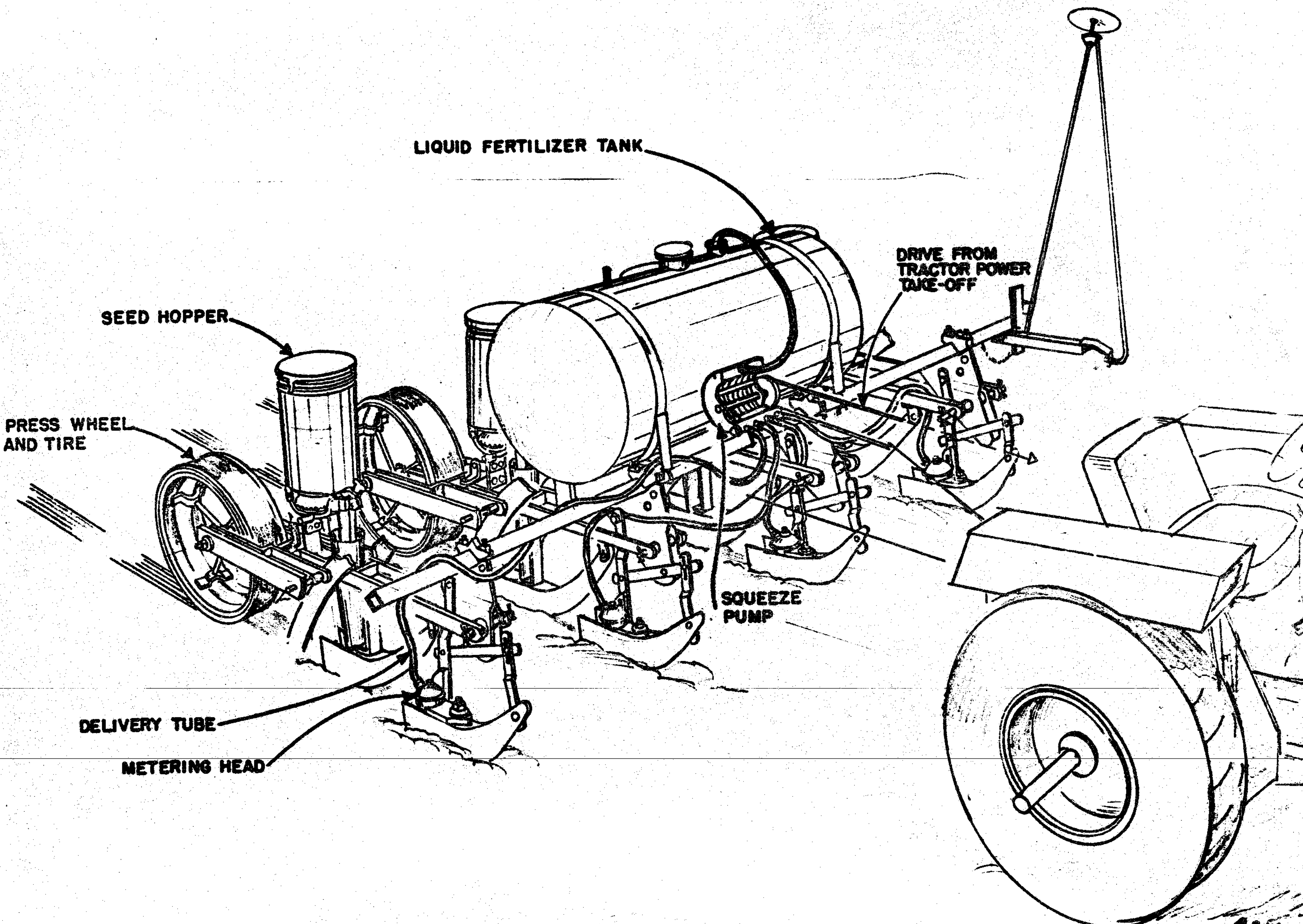


FIGURE 9

ROW APPLICATION OF SUSPENSIONS

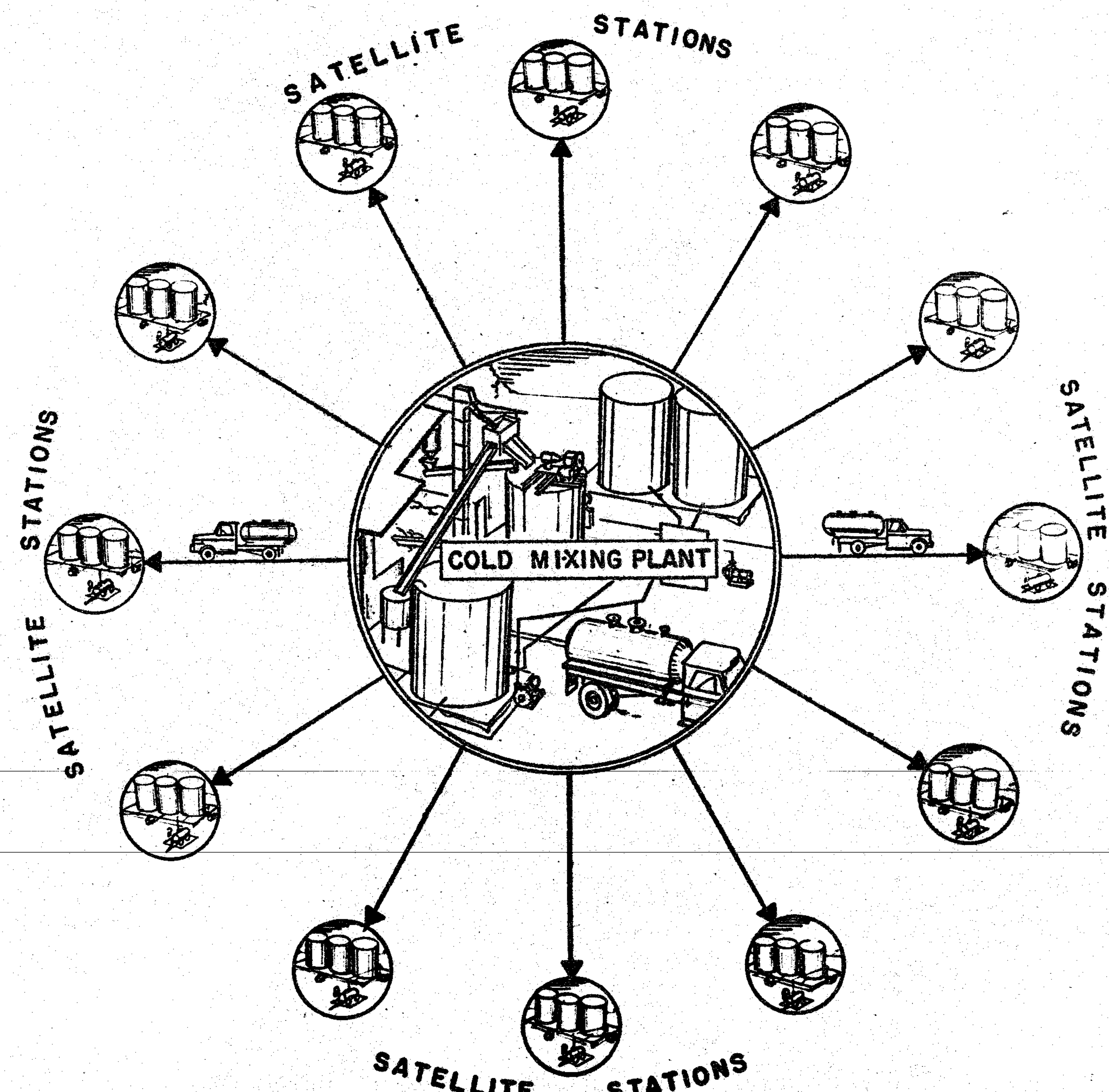


FIGURE 6
MARKETING SYSTEM PLANT AND SATELLITE STATIONS