THE USE OF SYSTEMIC INSECTICIDES FOR CONTROL OF POTATO INSECTS[1]

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Five insecticides capable of penetrating living tissues and moving through the sap-conducting system of plants have been registered for use in the control of certain pests of potatoes. The systemic life of these compounds varies considerably. These insecticides also kill pests on direct contact as well as by fumigation. Three of the systemic insecticides are available only as emulsifiable concentrates suitable for spraying the foliage and the remaining two may be used only as 40-60 mesh to the square inch size granules applied to the soil in which crops of potatoes are to be grown.

A single application of one of these granular, systemic insecticides made at planting time has been reported to "provide even, steady control through the season" of aphids and leafhoppers, and "consistently produced larger yields than unprotected potatoes" in the Middle West. Other favorable but less dramatic results from the use of systemic insecticides for control of various potato pests have also been reported from parts of the East and Southwest.

Approximately a dozen insecticides with systemic properties have been applied experimentally to potatoes in various ways and evaluated for pest control in Eastern Washington for one to seven years. Considerable differences in performance were observed between the systemics, but many of them gave good to excellent control of aphids and certain other pests for periods ranging from a few days to ten weeks. However, when used as a single application by any of several methods, no systemic - including the five registered for use - provided season-long control of aphids, or leafhoppers, or consistently produced greater yields of potatoes as has been reported elsewhere.

Although systemic insecticides are not likely to replace the established potato insect control program in Washington, some are useful for specific jobs, or during a limited period of crop production. A knowledge of the strong and weak points of each systemic insecticide should be helpful in choosing the best material for use at a particular time and place.

Properties that impart systemic qualities in some insecticides are not fully understood but depend upon several complex chemical and physical factors. Although the solubility of the insecticide in water may show little relation to its systemic qualities, translocation must take place chiefly in the water-conducting tubes because movement is invariably upward from the point of contact with the plant. Absorption and translocation are most rapid in young,

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1/ The discussion of any pesticide in this report does not imply recommendation and you will note that none of these systemic insecticides are included in our recommendations as outlined in E.M. 2109, "1962 Potato Insect Control Calendar for Washington". This report may not be published without prior approval of Washington State University and The USDA, Agricultural Research Service, nor may it be used in sales promotion or advertising which implies endorsement of the product.

vigorous plants and very slow or not at all in mature plants. On entering the plant, the systemic may change to a different compound which may be more toxic to pests than the original. Gradually the toxic compound may break up into others having little or no toxic properties, and this characteristic makes the insecticide especially useful in pest control on food crops.

All five of the systemic insecticides registered for use on potatoes are organic phosphates related to and either toxic as or more so than parathion. They are less stable than some other systemic insecticides and although this is desirable in order that objectionable residues may disappear from treated crops, there are disadvantages as well. The toxicity of the systemic phosphates is greatly reduced when they are mixed with alkaline materials. It seems possible, therefore, that the alkaline nature of Eastern Washington soils may be partly responsible for failures of soil applications of the systemics to protect potato crops from pests for as long as has been reported in other areas.

The type or texture of the soil in which systemics are applied and cultural practices used may also affect their performance. Higher dosages have been suggested for clay than sandy soils, presumably because clays slow down the rate of absorption of the insecticides through the roots. Delay in plant emergence from the soil, and minor toxic symptoms in young plants, have been observed occasionally in treated light, sandy soil and rapid absorption of the chemicals is presumed to be responsible for these abnormalities. Although systemic granules may be applied to soil as the crop is planted in March or April, absorption proceeds very slowly into the plants until the field is irrigated. Systemics are absorbed more efficiently by plants irrigated with sprinklers than with rills.

Systemic insecticides occasionally produce odd, although usually unimportant, growth characteristics in potato plants. Under certain conditions plant growth may be either delayed or accelerated, the leaves may be thinner or thicker or even more deeply veined than non-treated plants. In one case where a systemic insecticide was applied to the soil as the crop was planted in early spring, the plants grew rapidly and were more susceptible to frost than non-treated plants. In another case, no blossoms developed in large plots where a particular systemic was applied to the soil.

Comparison and Evaluation of Systemics

Systemics Available for Treating the Foliage

The three systemic insecticides that are commercially available are emulsifiable concentrates which lie within a range of toxicity to man, equal to but not more than twice that of parathion. Demeton (Systox) is least toxic to man, Phosdrin most toxic, and phosphamidon (Dimecron) occupies an intermediate position.

Demeton is registered for use as a spray on potatoes at the rate of ½ pound of active ingredient per acre/application. Although the manufacturer suggests that applications be repeated as necessary, none should be applied withing 21 days of harvest. A tolerance of 0.75 ppm demeton is allowed in the harvested tubers.

Demeton is the oldest systemic registered for use on potatoes and seems to perform better in the cooler seed-producing areas than where table stock is grown. Applications made in Eastern Washington at the registered dosage may be expected to control aphids and leafhoppers on potatoes for 7 to 14 days during the period of June 15 to August 15, when reinfestations may occur rapidly. It has considerable value as a contact insecticide and gives fair control of the two-spotted spider mite when applied at the maximum allowable dosage.

Phosphamidon is registered for use as a spray on potatoes at the rate of 1 pound of active ingredient per acre/application. The registration has been made on the basis that no residue will be found in potato tubers harvested 30 days or more after the last application.

Phosphamidon is water soluble and also moves swiftly through young potato plants after application. Aphids and similar small sucking insects are killed quickly on contact and also during the feeding process immediately after application, but the insecticide decomposes rapidly in the plants and becomes non-effective against most potato pests in approximately one week. It provides fairly good control of the two-spotted spider mite for a few days.

Phosdrin is registered for use as a spray on potatoes at the rate of $\frac{1}{4}$ pound of the active ingredient per acre/application. Any reasonable number of applications may be made of this versatile insecticide up to one day before harvest. A tolerance of 0.25 ppm of the active ingredient in Phosdrin is allowed in potato tubers.

Phosdrin kills aphids, thrips, leafhoppers and many other small insect pests of potatoes swiftly and within a few hours after application but has the shortest life of any of the systemics. It is effective against the two-spotted spider mite, but at least two applications made four to five days apart are required to kill mites that hatch after the last application.

Systemics Available for Treating the Soil

The two systemics that are commercially available in granular form are much more toxic to man than the three available as emulsion concentrates. Formulation of these as dry granules, however, makes them much safer to handle and apply.

Phorate (Thimet) is registered for use as 10% granules in the furrow or in bands to each side of the row at planting time at the rate of 3 pounds of the active ingredient per acre. Registration has been made on the basis that no residue will be found in potatoes harvested when mature.

Repeated experiments involving the use of 3 pounds of phorate per acre in clay soil and 2 to 2-1/2 pounds per acre in light, sandy soils of Eastern Washington have given good control of aphids and leafhoppers for as much as 60 days after application. Soil insects, such as wireworms, flea beetles, and symphylans were not controlled throughout the season.

Di-Syston is also registered for use in granular form on potatoes and at the rate of 3 pounds of the active ingredient per acre. A tolerance of 0.75 ppm of the active ingredient in potato tubers has been established, and crops are not to be harvested within 90 days of treatment.

Repeated experiments with Di-Syston at the registered dosage gave good control of aphids and leafhoppers for 60 to 70 days after application. Soil insects were not controlled throughout the season.

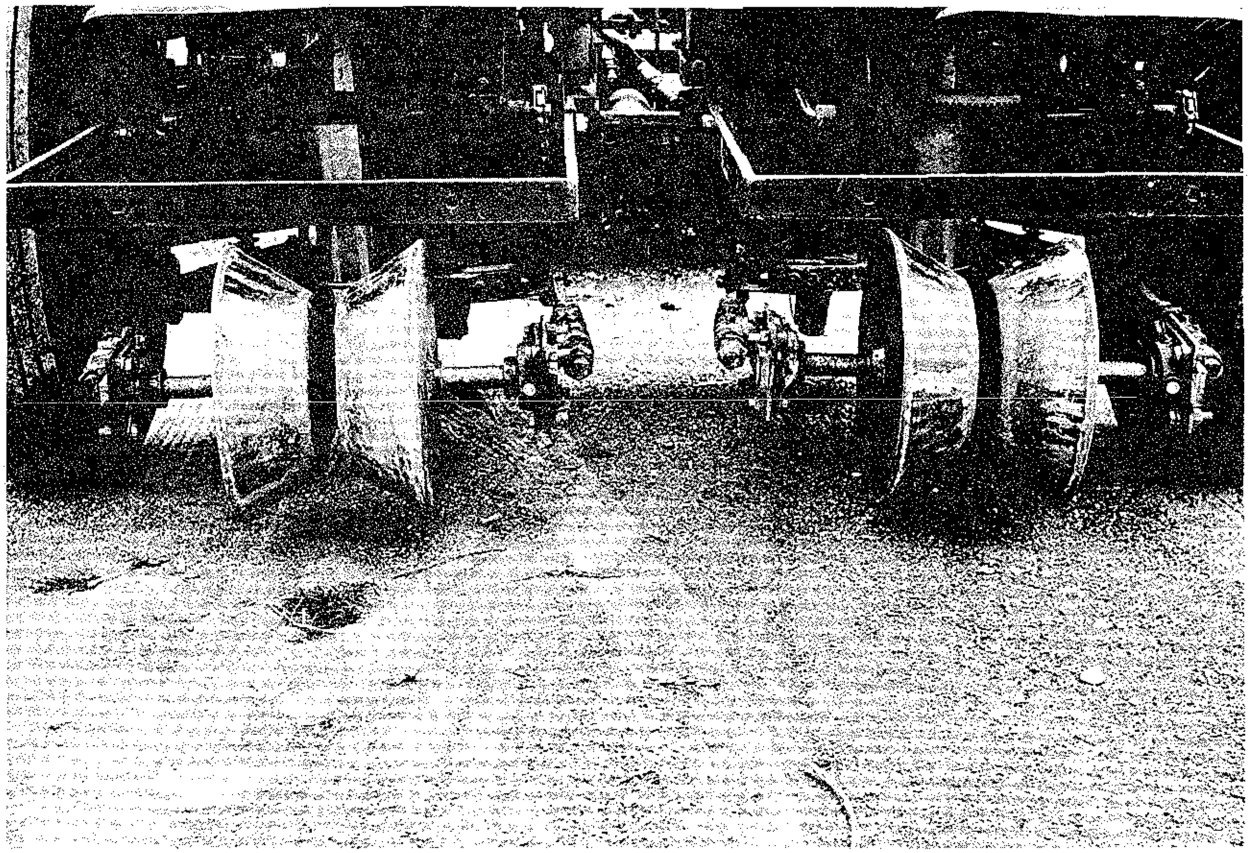
Use of Systemic Insecticides on Summer and Fall Crops

Granular systemic insecticides applied when potatoes are planted from the middle of March to the middle of May for the summer crop have been observed to control aphids to the end of May, in the case of the very early planting, or to mid-July with the later planting. Although a few aphids may appear on potatoes the first week of May, the infestation increases slowly and no aphids may be found in fields in some areas until the end of May, even though no systemics were applied. In any event, aphid propogation on potatoes does not increase rapidly until some time after mid-June when half or more of the anticipated period of effectiveness of the treatment may have already passed. Fields of potatoes treated with granular, systemic insecticides at the registered dosage in mid-May 1961 were sufficiently infested with aphids and leafhoppers in mid-July to warrant additional treatment with other insecticides.

The later the potato crop is planted in the season the more likely it is that the soil application of systemic insecticides will control aphids and other pests during critical periods of infestation.

Care in Applying Systemics

The systemic insecticides are very poisonous and should be applied with extreme care. Foliage applications of systemic insecticide sprays are about as effective when applied with aircraft as with ground equipment. Wear a respirator or mask of a type that has been tested by the U. S. Department of Agriculture and found to be satisfactory for protection against the particular insecticide being used. Toxic fumes and dust arise from granular insecticides. The use of respirators is as essential while loading granular applicators as in operating spray equipment.



EXPERIENCES WITH THE WSU PRESS WHEEL POTATO PLANTER

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The theory for and the results of one year's experimentation with press wheel planting of potatoes were reported in 1961. The increased yield and grade obtained by comparison with the conventional planting made the use of the press wheels appear to be at least a partial answer to the industry problems of stand, grade, wind erosion, weed control, and moisture snubbing into the ridges. As a result, many sets of press wheels were bought and tried in 1961 with varying degrees of success. The industry moved so fast in their acceptance of the idea and so little was known about the problems which might arise from deep planting and shallow covering of the seed pieces, or how press wheels could be mounted on planters which differed from the ones used in the experiment, that much concern was felt about the outcome. In spite of all the improvisations for attaching press wheels to picker planters, and the differences in depth of planting, height of ridge, and dates of planting coupled with probably the hottest year on record for the Columbia Basin, there is still reason to believe that the principle of deep planting and shallow covering of the seed piece may on the average be superior to conventional method of ridging over the seed piece.

One of the most surprising facets of the problem was the effect it had on the non-users of press wheels. High ridges over the seed pieces, a common sight during past years, were in most cases harrowed or dragged off until the land was essentially flat but subject to blowing.

The principle of deep planting and shallow covering of the potato seed piece is illustrated in Figure 1.

It is readily apparent that under conventional planting the young sprout has 3 inches farther to grow to daylight than in the case of the press wheel planting. Ridges over the seed piece as high as 8 to 10 inches have been measured. The longer it takes the young plant to emerge, the longer it will take for the young plant to become self supporting.

The loose, porous and often cloddy soil around the seed piece, as in conventional planting, is in poor contact with the subsoil, and water will move slowly from deeper in the soil into the vicinity of the seed piece, if at all. In comparison, the movement of water under the press wheel planted seed where the soil particles have been pressed close together and are in good contact with the subsoil moisture is rapid.

In addition, the shallow covering with the inverted "V" shaped ridge tends to collect the water from light showers of rain along the edges where penetration of the water into the root zone is only a matter of a very short distance. With conventional ridging following planting, the water is spread over a larger area, and may never penetrate to more than ½ inch or so below the surface, the result of which is to stimulate weed growth.

Records of the temperature at the seed piece have shown that the temperature is usually a little higher on warm days and a little cooler at night under press wheel planting than under conventional ridging where the temperature at the seed piece is relatively uniform. Observations have been made where press wheel planting has resulted in considerably faster emergence, where it has made no difference, and in at least one known case where the seed was planted too shallow, the young sprout took longer to emerge and the stand was spotty. The rate of emergence is conditioned by the air temperature, which in turn influences the soil temperature and consequently the seed piece and the young plant. Differences in soil temperature at the seed piece level on a warm cloudy day under press wheel and conventional ridge planting have differed by as much as 16 degrees Fahrenheit.

Theoretically, weed control under the two methods of planting should be easier

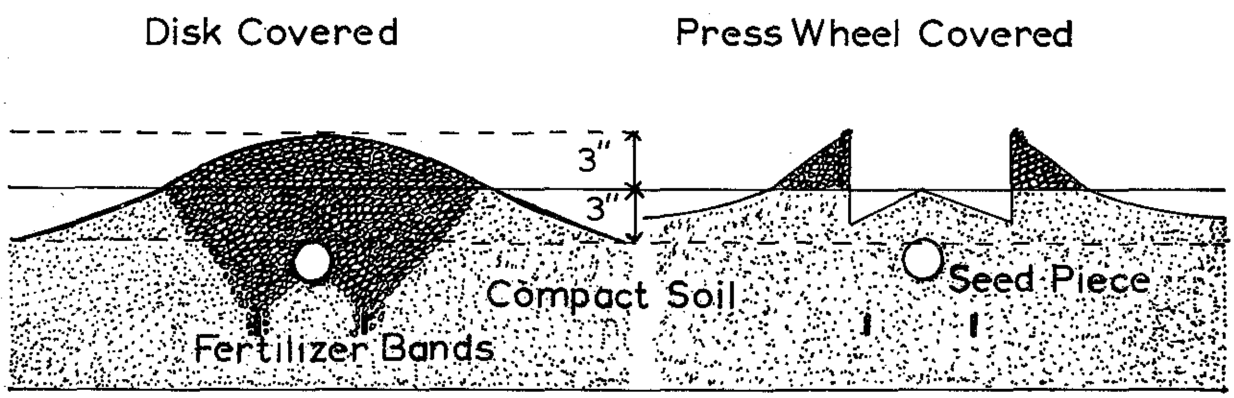

Figure 1. A proportional comparison between conventional planting and press wheel planting.

with press wheel planting because it is easier to cover something in a furrow than it is to cover something on a ridge. The industry has been concerned about weed control, but this concern was based on a lack of experience in handling a new concept in planting. Flame weeding to replace the first cultivation when the plants are just beginning to come through the ridge left by the press wheels looks interesting.

Figure 2 illustrates the different kinds of growth which take place under the two methods of planting, unless the conventional ridges are harrowed or dragged off. Young plants which grow in the dark tend to have long internodes (are long between joints) and it is from the nodes that both the tuber-forming stolons and the roots develop. If the ridges are high, the stolons and roots form high in the ridge where the temperatures are highest and the soil is difficult to wet and keep moist because of the distance the water must move by capillarity.

During the early part of the season the soil in the ridge is moist and warm. Because of these conditions, roots develop profusely in this area. If the ridge is later permitted to dry out, these roots stop working and absorb neither water nor nutrients.

The results of experiments in 1960 showed encouraging reductions in the degree of Rhizoctonia infection and girdling. These observed effects are now being studied

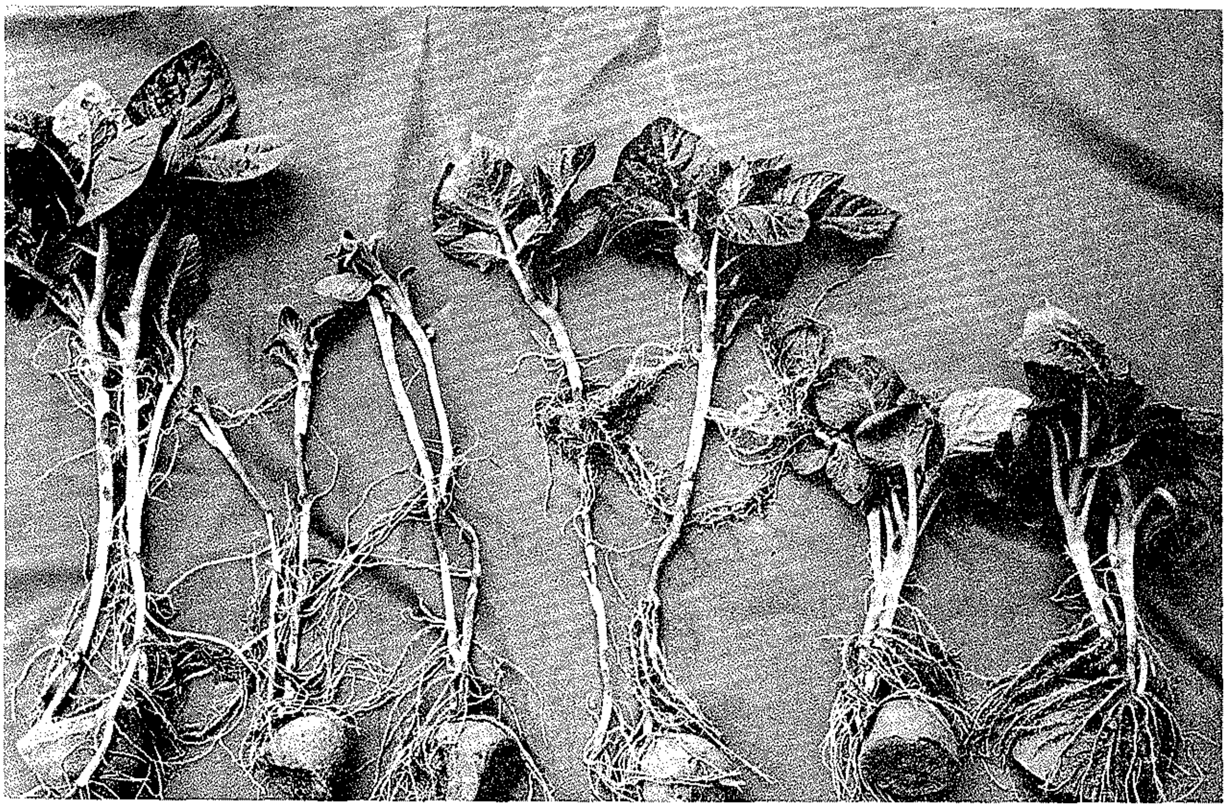

Figure 2. Effect of height of ridge on the length of internodes and on the location of root and tuber development.

systematically under controlled conditions. However, let us assume that there are no differences in the degree of Rhizoctonia girdling under the two methods of planting. It is well known that severe girdling forces the growth of roots and stolons above the girdled area. In press wheel planting the stem area exposed to girdling is only 2 or 3 inches. The roots and stolons formed above this area are still able to grow with a minimum of hilling. In conventional ridges the Rhizoctonia girdling often extends up the stem for 5 or 6 inches or more. To maintain the roots and stolons above this area requires extreme hilling with its problems of proper irrigation.

Whether Rhizoctonia is present or not, the press wheel method of planting has resulted in a deeper set of tubers, and harvesters have had to be adjusted deeper when used on press wheel plantings than in adjacent rows conventionally planted.

Greening of the tuber does not seem to be a problem with press wheel planting, even when the hilling consists of little more than filling in the furrow over the ridge left by the press wheels, but to be sure, especially if weeds are a problem, some hilling would be beneficial.

On light soils where wind erosion is a problem, planting 3 inches deep with the press wheel seems to reduce greatly the tendency for seed to blow out. In numerous observations where the direction of the wind was across the field, the seed pieces actually were covered deeper after a wind storm than before. This is not surprising, since the soil in the ridge on one side of the seed is blown against the ridge on the opposite side. There have been cases, however, especially where the wind blew in the same direction as the rows, when press wheel planting seemed to make little difference.

Because of the varied methods of mounting press wheels and the variation in depth of planting and height of ridging, it seems advisable to made available to the potential users of press wheels the dimensions of the essential planter parts as arranged in the experimental work.

The fertilizer opening disks (A) are 14 inches in diameter and flat. The fertilizer tubes (B) place the fertilizer about 2 inches on each side and slightly below the bottom of the seed piece. The seed opening shoe (C) is

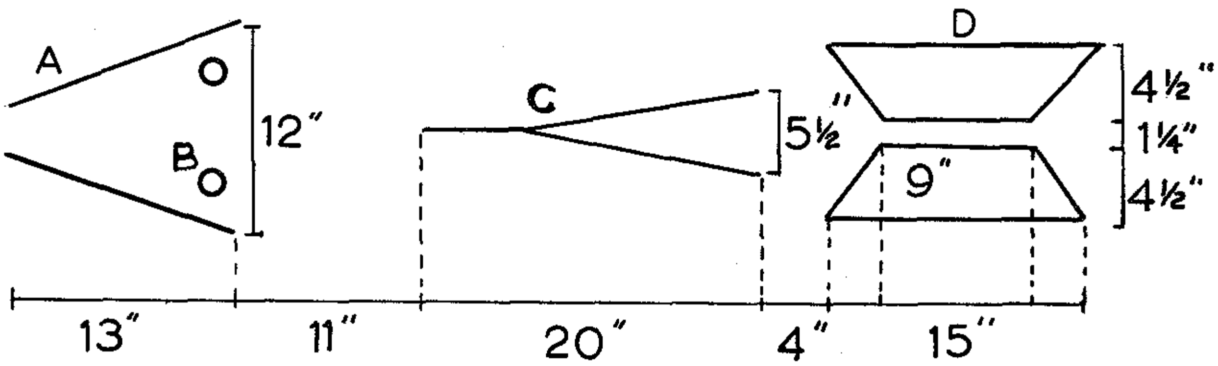

Figure 3. A proportional sketch of the arrangements and distances between the planter parts.

relatively long and narrow in comparison with the short, wide opening shoes on the John Deere and International planters. The wide opening shoe tends to make a wide furrow for the seed, and it is necessary to mount small disks or blades in such a manner that ample soil is thrown over the seed piece prior to rolling with the press wheels. With the WSU planter, the press wheels (D) extend far enough beyond the outer edge of the opening shoe to move sufficient moist soil over the seed to cover it adequately. Adequate coverage of the seed piece has not been a problem except on poorly leveled land or on land with a great deal of grass sod.

Figure 4 shows the arrangements of the parts of a WSU press wheel assembly. The wheels with the space for eliminating excess soil are shown at (A). The axle with the collars for adjusting the distance between the wheels is designated (B), and the self-aligning bearings at the ends of the axle are designated (C). The self-aligning bearings are bolted to a metal plate to which has been welded a short section of pipe (D) which fits on the arms to which the covering disks are normally attached.

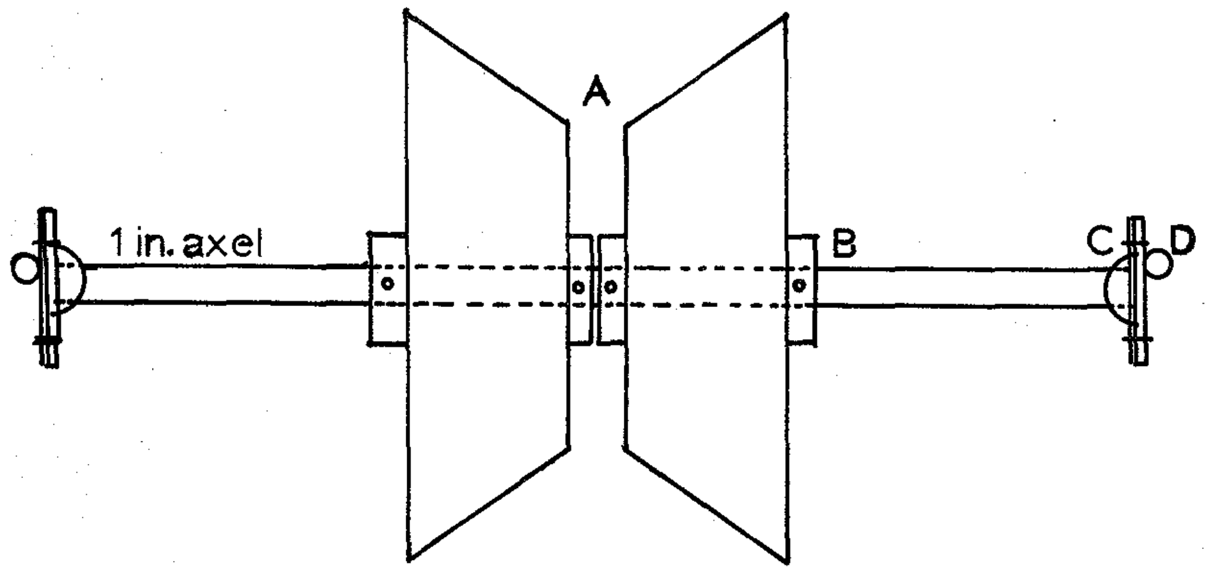

Figure 4. Arrangements of the parts of a WSU press wheel assembly.